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Parental Investment and Peer Effects in Cognitive and Non-Cognitive Skills

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Abstract

This paper investigates whether and how parents adjust their parenting behavior in response to their children's peers. In particular, I analyze whether changes in cognitive and non-cognitive skills of children's friends lead parents to adjust their investment and parenting style such, as monitoring and quality time spend with their children. Data from Add Health allow me to follow five cohorts of teenagers from grades 7 to 12 with repeated information on individual friendship networks. Combining the empirical strategy of overlapping peer groups and first-differencing, I estimate a simultaneous system of skill and investment equations. First, I show that parental monitoring increases as the level of cognitive skills among peers decreases. Also, mothers compensate decreases in cognitive skills of their child's peers by increasing verbal investment, while fathers reinforce higher non-cognitive skills of their child's peers with joint activities. Second, I document gender differences in monitoring, where cognitive skills of sons' peers are compensated but non-cognitive skills of daughters' peers are reinforced. Overall, effects in time investment are driven by parents with high educational expectations of their child, and parents that have no close relationship with peer-parents. Third, parental response to peers is not limited to peer skills, the composition of peers as measured by their characteristics also leads to an adjustment in the parenting behavior.

Keywords: Child Development, Family Investment, Peers, Skills, Non-Cognitive Skills
JEL Classification: J13, J24, D13

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1 Introduction

The importance of parental investment for the human capital development of children has been shown in various ways (Cunha and Heckman, 2008; Cunha et al., 2010). Parents continuously adjust their allocation of different investment types over the age of their child (see e.g. Del Boca et al., 2014, 2017). Doing so allows maximizing their child's human capital (cognitive and non-cognitive skills). At the same time, the social environment constructed by classmates, friends, or siblings influences an individual's educational achievement (see e.g. Carrell et al., 2013; Hoxby, 2000). However, little is known about how these two factors interact. Are parents adjusting their parenting behavior to the social environment their child experiences, thereby compensating or reinforcing the influence of peers?

In this paper, I investigate whether and how parents adjust their parenting behavior in response to their child's close peers as defined by friendship nominations. I distinguish between two types of parenting behavior: parental investment, in particular quality time such as talk about schoolwork and joint activities, and parenting style, such as monitoring. I show the extent and means of parents' response to two different skills of peers: first, cognitive skills as measured by peers' scholastic performance, and second peers' non-cognitive skills as measured by their level of self-esteem. Moreover, comparing constant to time-varying peer groups, I allow parents to react on peer skills as well as peer background characteristics. Lastly, I investigate heterogeneous effects to give an insight into mechanisms driving parents' responses.

One way a parent can react to their child's peers is via residential choices. Selecting a neighborhood along the school quality allows parents to restrict their child's set of potential peers and hence close peers such as friends. In this paper, I take this decision as given, so that parents already chose their area of residence and the school their child attends. Thus I focus on whether parents react to the quality of their child's friends - given the "restricted set of potential peers". Depending on whether parents perceive friends as substitutes or complements to their parenting behavior, their response to peers' cognitive and non-cognitive skills and their characteristics will differ. Thereby, the focus of this paper is not on peer effects per se, but rather on parents' response to their child's peers.

Using data from the National Longitudinal Study of Adolescent of Adult Health (Add Health), I investigate how the skill development process of adolescents in grades 7 to 11 depends on own past skills, on past health status, on peers' skills and parental investment and parenting styles and, most importantly, how parental behavior is affected by the skills

and characteristics of their child's peers. It has been shown that peers have an important effect on high school students' outcomes, even in the long-run, and thus it is in the parents' interest to take their child's peers into account.[1]

The main challenge in analyses including peer effects is to distinguish between different sources leading to similar outcomes of individuals within the same group (Manski, 1993). Unobserved heterogeneity leading to selection into groups can confound results and lead to a conclusion of behavioral spillovers while the effect is driven by similar environments. To address these challenges and identify causal effects of peers I follow among others Bramoullé et al. (2009) and De Giorgi et al. (2010). I make use of partially overlapping peer groups, which is an instrumental variable strategy exploiting indirect links within a network, together with peer group fixed effects. To solve the problem of endogenous investments I use first-differencing, which differences out family and individual level fixed effects, and instrument skills with their lagged values (see Cunha and Heckman, 2007, 2008, who provide evidence for internal logic and validity of these instruments). To strengthen the instrumental strategy and capture the joint evolution of child skills and parental investment, I simultaneously estimate a system of two skill and one investment equation. This allows to account for direct peer effects on the child's skills and captures the reversed effect of parental investment on child's skills along with parents' response to peers of their children.

In the literature, there is limited evidence on parents' reaction to their child's social environment, though on a more general level. Exploiting the Romanian secondary school system Pop-Eleches and Urquiola (2013) were one of the first to show, that parents reduce their effort in case their child attends a better school. Similarly, Greaves et al. (2019) find in the context of England, that parents belief school quality and time investments to be substitutes. That these response patterns can differ between parents is shown by Fredriksson et al. (2016), who exploit a maximum class size rule in Sweden. In the context of intergenerational transmission of religion, Patacchini and Zenou (2016) show that parental investment (targeting explicitly the transmission of religious values) and peers as measured by close friends are complements. This study aims to contribute to this literature by expanding the focus on how parents respond to the skills, behavior, and characteristics of close peers. Thereby it contributes to shedding light on how parents make decisions concerning investment into their child and providing evidence on parents' perception of their child's skill development process. Moreover, this study adds to the literature on

[1] See e.g. Gaviria and Raphael (2001) for drug use, church-going, dropping out of school; Lin (2015) for drugs, smoking, school skipping, physical fighting; Yakusheva and Fletcher (2013) for teenage pregnancy.

social interactions, since it shows how parental behavior might moderate/reinforce the effects of peers. Lastly, this study can provide insights into how parental response can mediate school level policy interventions aimed at changing student compositions.

To the best of my knowledge, the only other paper looking at individual level friends is Agostinelli (2018), who incorporates peers into the parental investment decision by including average peer skill into the cognitive skill development function. Using a dynamic equilibrium model the author shows that parents and peers constitute a dynamic complementarity. While I do not use a structural model, in contrast to Agostinelli (2018) I investigate parents' response to peers' skills as well as peers' (time-constant) characteristics. Also, instead of constructing one overall parental time investment measure, I distinguish between time mothers and fathers spend on verbal interactions and time spend on joint activities with their child, and given the growing evidence on the importance of parenting style (see e.g. Cobb-Clark et al., 2019; Doepke and Zilibotti, 2017), I provide insight on how parents adjust their parenting as measured by monitoring.

I show that parents change their behavior in response to changes in the skills or the characteristics of their child's peers in three main ways. First, parents compensate for decreases in the cognitive skill of their child's peer by increasing monitoring. Also, I provide evidence that parents not only respond to the cognitive performance of peers but also consider peer non-cognitive skills in their investment decision. In particular, while mothers compensate for cognitive skill losses of their child's peers by increasing verbal investment, fathers reinforce high non-cognitive skills of peers by increasing time spend on joint activities with their child. These response patterns indicate that verbal investment and monitoring are perceived as substitutes to peer cognitive skills, and joint activities are seen as complements to the self-esteem of peers.

Second, allowing parents to react differently in the case of daughters as opposed to sons, I document gender differences for monitoring. While cognitive skill losses of sons' peers are compensated by increased monitoring, for daughters increased peer self-esteem is reinforced with higher levels of monitoring. Adjustments in time investment are mainly driven by parents that have no close relationship with peers' parents, and parents that expect their child to attend college. However, results do not differ by parental education. Adjustments in monitoring and the verbal investment of mothers are mainly driven by children who have below-median cognitive skills, suggesting that parents try to prevent negative spillovers on their "at risk child".

Third, by exploiting repeated information on friendship nominations, I show that par-

ents take peer characteristics along with peer skills into account. In addition to compensating cognitive skill losses, mothers compensate for decreases in the fraction of white friends by increasing verbal interactions. On the other hand, a higher fraction of peers with educated parents leads mothers to reinforce this peer quality gain by increasing verbal investment into their child. As opposed to that, fathers' response and parental monitoring is mainly driven by changes in peer group quality as measured by the composition of peer characteristics rather than peers' skills.

My findings suggest that school or classroom level interventions changing the composition of students will lead to feedback effects through parents. As I show, parents consider peer quality as measured by skills and characteristics in their parenting behavior. This means, depending on the skill considered, the net effect of policy interventions might be under- or overestimated if parental responses are not taken into account.

The remainder of the paper is structured as follows. In section 2 I discuss the related literature. In Section 3 I shortly present the conceptual framework, and in Section 4 I describe in detail the identification and estimation strategy. The sample and variables are described in Section 5 and results are discussed in Section 6. Robustness checks are provided in Section 7 and Section 8 concludes.

2 Related Literature

This paper builds on work from the child development literature and in particular parents' role in it, and on work from the peer effects literature in the educational context.

There are a series of papers highlighting the role of parental and public investment in the process of skill development. Distinguishing between cognitive and non-cognitive skills, it is shown that parental inputs are more influential to determine cognitive skills at early and non-cognitive skills at later ages (Cunha and Heckman, 2008). Exploiting non-linearities within a dynamic factor model Cunha et al. (2010) determine substitution patterns between contemporaneous investments and skills inherited from previous periods. They provide evidence for dynamic complementarity[2], suggesting that the optimal strategy in supporting disadvantaged children starts with early childhood interventions in cognitive skills while targeting adolescents should involve the promotion of non-cognitive skills. Even though skill models can pinpoint optimal investment strategies over the childhood, they

[2]Dynamic complementarity captures the feature that skills produced in one stage of childhood increase the productivity of investments a subsequent stages.

do not directly incorporate the child's environment. This paper investigates the role of the child's social environment in the optimal parental investment decision.

The literature mainly distinguishes between two forms of parental investment, monetary and non-pecuniary. The first covers expenses for books, private tutoring or extracurricular activities[3], the latter refers to quality time spend with the child such as reading to or with the child. In the British context, Del Bono et al. (2016) show that maternal time investment positively affects cognitive and non-cognitive development of 3-7 year old children. Distinguishing between active time, including direct interaction, and passive time, indicating presence but not an engagement of a parent, Del Boca et al. (2014) underline the importance of both types of time investment on cognitive development. This paper distinguishes between two types of time investment, verbal interactions and joint activities.[4] The former includes only interactions between parent and child that occur on a verbal basis, covering topics such as school work, grades, and personal problems the child is having. The latter focuses on interactions during joint activities such as sports or social events and support for school work.

Finding from the literature in health economics show that the (early) health of an individual is related to educational outcomes like achievement and can have even implications in terms of intergenerational mobility (see e.g. Currie, 2009). Hereby it has been shown that health shocks during early childhood can have long lasting drawbacks (see e.g. Oreopoulos et al., 2008), while interventions targeting the improvement of health during childhood can have long-run benefits (see e.g. Butikofer et al., 2019). These results suggest that it should be interest of a parent to respond to the health status of their child, which is why in this paper I allow parents to adjust their investment and monitoring in response to their child's current health. Yi et al. (2015) and Nicoletti and Tonei (2017) show, parents do respond to their child's health with both monetary and time investment so that leaving it out could confound results. In line with that, I show that parents compensate health losses of their child by higher levels of time investment.

The existence and importance of peer influences have been documented in various areas. Depending on the particular topic at hand, mechanisms and thus reasons for these effects

[3]e.g. see Plug and Vijverberg (2005) who shows how important parental income is the context of education in general, Del Boca et al. (2017) who analyze the role of monetary investment over the childhood, and Carneiro et al. (2015) who show how parental income shocks at different times in childhood can reflect itself in intergenerational mobility via the education of the child

[4]The importance of active time investment is also underlined indirectly by the literature looking at effects of day care, e.g. see Fort et al. (2019).

differ. Peers or social networks can serve as a source of information so that individuals can learn from others (see e.g. Banerjee et al., 2013; Cai et al., 2015), but can also lead to the encouragement of imitating one another (see e.g. Patacchini and Arduini, 2016). This possible effect due to peer pressure or a desire to conform has been documented in the context of education decisions (see e.g. De Giorgi et al., 2010) as well as risky behavior.[5] In the education context, it has been shown that indirect influences of disruptive behavior in class negatively affects performance (see e.g. Neidell and Waldfogel, 2010) and can have long-lasting consequences (see e.g. Carrell et al., 2018), while good peers creating an atmosphere easing teachers' instructions is positively related to achievement (see e.g. Golsteyn et al., 2017; Lavy and Schlosser, 2011). While it is not always possible to pin down the channel of peer effects, a consensus has been reached that all students benefit from higher achieving schoolmates (see e.g. Hoxby and Weingarth, 2005) and might suffer from very bad performing ones (see e.g. Lavy et al., 2012b). In line with this, I find positive peer effects in cognitive skills, indicating that having friends with high cognitive performance supports the own cognitive development.

The Literature provides to main ways to reach causal identification in the analysis of peer effects. The first exploits quasi-experimental variation in the reference group composition (see e.g. Lavy and Schlosser, 2011) or random assignment rules provided by an administrative instance (see e.g Feld and Zölitz, 2017; Sacerdote, 2001). The second makes use of the existing network structure and is more data demanding. Individual specific peer groups are created to exploit variations in group sizes (see e.g. Lee, 2007) or the existence of indirect links (i.e. peers of peers) (Bramoullé et al., 2009; De Giorgi et al., 2010). This paper is based on the Add Health database which has rich individual-level network information. Exploiting individual friendship nominations I follow the second approach and make use of intransitivities within the available networks.

3 Conceptual Framework

In what follows, bold letters capture vectors, subscripts mark individuals (i) and time (t), and superscripts indicate different skills with N referring to non-cognitives and C denoting cognitives. Suppose parental utility depends on own consumption c, child's acquired skills

[5] See e.g. Gaviria and Raphael (2001) for drug use, church-going, dropping out of school; Lin (2015) for drugs, smoking, school skipping, physical fighting; Yakusheva and Fletcher (2013) for teenage pregnancy.

$\boldsymbol{\theta}_{it}$, and parental human capital level $\theta_{Parent,i}$.

$$U(c_{it}, \boldsymbol{\theta}_{it}, \theta_{Parent,i})$$

where $\boldsymbol{\theta}_{it} = [\theta_{it}^C, \theta_{it}^N]$ is a vector containing two skills, with θ_{it}^C indicating cognitive skills and θ_{it}^N non-cognitive or socio-emotional skills. At each developmental stage $t = 1, ..., T$ of their child, parents maximize the expected discounted sum of their future utility subject to the child's skill production function (1) and parental budget constraint (2).

$$\theta_{i,t+1}^k = g^k(\boldsymbol{\theta}_{i,t}, \theta_{Parent,i}, I_{i,t}, \boldsymbol{\theta}_{Peer,t}, \mu_i^k, \eta_{it}^k), \quad k = C, N \tag{1}$$

$$Y_{it} = c_{i,t} + p_t^I I_{i,t} + s_{i,t} \tag{2}$$

where I_{it} captures parental investment, $\boldsymbol{\theta}_{Peer,t}$ are peer skills, μ_i^C and μ_i^N are child and/or family level time-constant unobservables in each skill function, η_{it}^C and η_{it}^N capture idiosyncratic shocks in each skill function, Y_{it} is family income, p_t^I captures the price of investment, and $s_{i,t}$ allows for savings. Solving this dynamic problem will yield a policy function for parental investment

$$I_{it} = f_t(\boldsymbol{\theta}_{it}, \theta_{Parent,i}, \boldsymbol{\theta}_{Peer,t}, Y_{it}, p_t^I, \mu_i^C, \mu_i^N, \mu_i^I, \eta_{it}^C, \eta_{it}^N, \eta_{it}^I) \tag{3}$$

Parental investment is a function of their child's set of skills ($\boldsymbol{\theta}_{it}$), their own level of human capital ($\theta_{parent,i}$), their child's peers' set of skills ($\boldsymbol{\theta}_{Peer,t}$), parental income ($Y_{it}$), price of parental investment (p_t^I), child and/or family level time-constant unobservables in the skill (μ_i^C, μ_i^N) and investment function (μ_i^I), idiosyncratic shocks in the skill function (η_{it}^C, η_{it}^N), and idiosyncratic shocks in the parental investment function (η_{it}^I). While this and similar frameworks have been widely used,[6] the inclusion of peers is usually not considered.[7] However, if parents take the peer group quality of their children into account while making their decision, leaving peers out of the analysis will lead to misleading results.

As a simplified example suppose there are only two periods, the first where the child can receive investment from the parent and a second in which the child already reaches adulthood. For clarity of notation suppose there is one joint measure $\theta_{i,t}$ including both,

[6] see for instance Cunha and Heckman (2008), Del Boca et al. (2014), Almond et al. (2018)

[7] As of my knowledge, only Agostinelli (2018) incorporates peers into a similar conceptual framework considering a single skill dimension.

cognitive and non-cognitive skills. Then the parents' problem will be

$$max \quad U(c_{i,1}, \theta_{i,1}, \theta_{Parent,i}) + \beta U(c_{i,2}, g(\theta_{i,1}, I_{i,1}, \theta_{Peer,1}), \theta_{Parent,i})$$

$$s.t. \quad c_{i,1} + p^I I_{i,1} + \frac{c_{i,2}}{(1+r)} = Y_{i,1} + \frac{Y_{i,2}}{1+r}$$

The optimal investment decision will then be derived from

$$p^I(1+r)\frac{\frac{\partial U(c_{i,2},\theta_{i,2},\theta_{Parent,i})}{\partial c_{i,2}}}{\frac{\partial U(c_{i,2},\theta_{i,2},\theta_{Parent,i})}{\partial \theta_{i,2}}} = \frac{\partial g(\theta_{i,1}, I_{i,1}, \theta_{Peer,1})}{\partial I_{i,1}}$$

Whether and how exactly peer skills enter the parental investment function depends on the specified functional form of the parental utility $U(c_{i,t}, \boldsymbol{\theta}_{it}, \theta_{Parent,i})$ and the child's skill production function $g(\theta_{i,t}, I_{i,t}, \theta_{Peer,t})$.However, from the simple first-order condition above, it can be seen that parental response to peers will depend on two things. First, the direct influence of parents on their children which is captured by how $I_{i,t}$ enters $g(\theta_{i,t}, I_{i,t}, \theta_{Peer,t})$, and second, the way peer skills and parental investment interact in the child's skill production.

Ex ante it is not clear whether parents should increase or decrease their investment with higher skills of their children's peers. Suppose parents have a positive influence on the child's skill development, i.e. $\frac{\partial g(\theta_{i,1}, I_{i,1}, \theta_{Peer,1})}{\partial I_{i,1}} = g'_I > 0$, if in addition peers skills and parental investment foster each other ($g''_{I\theta_{Peer}} > 0$), then parents should increase their investment with increasing peer skills. However, if peer skills and parental investment enter as substitutes, i.e. $g''_{I\theta_{Peer}} < 0$, then parents should not increase their investment with increasing peer skills.

The main question aimed to be answered here is whether parents are sensitive to their children's social interactions. Which means whether parents adjust their investment in case they observe or perceive peer influences on their child. Hereby the exact functional forms of utility and production function leading to a parental investment function as described in (3) are not of main interest here. For this reason, in the following the optimal parental investment decision will be approximated by a linear function that is additively separable in its inputs.

4 Empirical Application

Assuming f_t, the parental investment function, is linear and additive in its inputs, it can be written as

$$I_{it} = \beta_0 + \beta_1 time_t + \boldsymbol{\theta'_{i,t}\beta_2} + \beta_3 \theta_{Parent,i} + G\boldsymbol{\theta'_{i,t}}\boldsymbol{\alpha} + X'_{it}\boldsymbol{\gamma} + \mu_i + \mu_g + \epsilon_{it} \tag{4}$$

where I_{it} captures parental investment of child i in period t; $\boldsymbol{\theta_{i,t}} = [\theta^C_{i,t}, \theta^N_{i,t}]$ measures human capital of child i in period t and includes cognitive and non-cognitive skills respectively; $\theta_{Parent,i}$ captures the human capital level of i's parent; $G\boldsymbol{\theta}_{it}$ captures the peer group quality of i's close peers in period t, hereby G is a spatial weighting matrix capturing how the individuals are connected so that the average skill level of peers is captured by $\frac{1}{n_g}\sum_{j=1}^{n_g} g_{ij}\theta_{jt}$ with n_g being the total number of close peers in group g and g_{ij} indicating a link between students i and j being the entries of G; X_{it} includes controls referring to parent or child; μ_i captures individual and family unobservables; μ_g represents peer group level unobservables; ϵ_{it} are idiosyncratic shocks. Equation (4) is basically the specification Nicoletti and Tonei (2017) use extended by peer effects. In contrast to Nicoletti and Tonei (2017), I specify parental investment to depend on contemporaneous skills instead of one period lagged skills. This is mainly for data reasons, information is available on a yearly basis, thus one lag could be too much reaction time for the parent. Also note, that parental investment and peer skills enter the skill development of child i in the same period, so that a contemporaneous specification allows parents to react on static complements or substitutes to their investment.

To estimate the above equation, unobservable characteristics of i and/or i's parent captured by μ_i, and peer group level unobservables measured by μ_g have to be eliminated. Hereby μ_g captures that friendship networks are not formed exogenously, which means there might be unobservables inducing both, changes in $\boldsymbol{\theta_{i,t}}$ as well as in the close peer group and thus $G\boldsymbol{\theta_{i,t}}$. This endogenous selection bias is controlled for by the use of peer group fixed effects. Under the assumption that conditional on individual and group unobservables peer groups are formed exogenously, i.e. $E[\epsilon_{it}|\mu_i, \mu_g, G] = 0$, I de-group-mean the whole equation for each period using $J = \mathbf{1_{n_g}} - \frac{\mathbf{1}}{\mathbf{n_g}}\iota_{\mathbf{n_g}}\iota'_{\mathbf{n_g}}$ which eliminates μ_g. Hereby J is a transformation matrix based on a n_g dimensional identity matrix $\mathbf{1_{n_g}}$, and two n_g dimensional vectors of ones, where n_g is the number of individuals in friendship group g. This conditional exogeneity assumption is violated if unobservables leading to friendship

formation and skill development vary over time. The validity of this assumption is assessed in the robustness section.

In addition to peer group fixed effects, I use first-differences to cancel out time invariant individual and family unobservables μ_i. Doing so relates changes over time in parental investment to changes over time in peer quality as well as child's quality as measured by their skills, which is summarized in equation (5).

$$\Delta JI_{it} = \beta_1 + \Delta J\theta'_{i,t}\boldsymbol{\beta_2} + \Delta JG\theta'_{it}\boldsymbol{\alpha} + \Delta JX'_{it}\boldsymbol{\gamma} + \Delta J\epsilon_{it} \tag{5}$$

Equation (5) as it is cannot be estimated due to two endogeneity issues. The first potential issue is that adjustments in parenting possibly induce changes in the child's peer group quality, at the same time since there is evidence of peer effects on skills there is a likely correlation between the child's skills $\boldsymbol{\theta'_{i,t}}$ and the peers' skills $G\boldsymbol{\theta'_{i,t}}$. These issues can be circumvented by instrumenting i's close peer group by second-order friends, i.e. friends of friends, which is referred to as partially overlapping peer group strategy.

This is the typical way of solving the endogeneity problem in the context of peer effects proposed and employed among others by Bramoullé et al. (2009), and Calvó-Armengol et al. (2009). Creating individual specific reference groups identification is reached using variations in group sizes (Lee, 2007), or given knowledge on who is not connected to whom, indirect peers (i.e. peers of peers) can be exploited (see e.g. Blume et al., 2015; De Giorgi et al., 2010). In this approach, the model is expressed in a spatial autoregressive way, wherein the specification of the weighting matrix, capturing the network structure, is the crucial point. With available data, networks can be taken as conditionally exogenously given so that the weighting matrix is specified directly from the data (see e.g. Lee et al., 2010; Lin, 2010, 2015).[8] Assuming that conditional on group fixed effects peer networks are exogenous, I specify the weighting matrix directly from the data.[9]

To understand the main idea behind the instrumental variable strategy of partially overlapping peer groups consider Figure 1. Figure 1a depicts a network in form of a big

[8] With less strict assumptions, endogenous networks can be included by joint modeling of outcome of interest and network formation directly see e.g. Goldsmith-Pinkham and Imbens (2013); Patacchini and Arduini (2016).

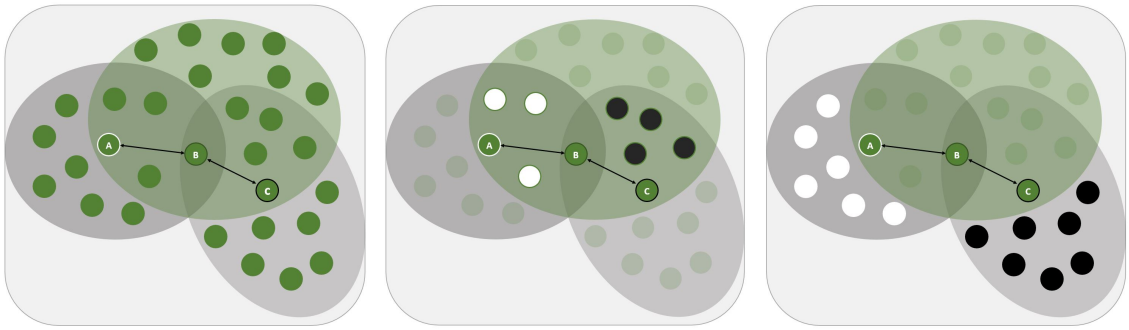
[9] Alternatively, exogenous peer group variations could be used. With the argument in mind that children are more likely to befriend others that are similar to them, quasi-random variations in the potential pool of fiends like cohort mates can be used, e.g. Hanushek et al. (2003); Hoxby (2002); Lavy et al. (2012a); Lavy and Schlosser (2011). This strategy wouldn't work in the current analysis since first differences are considered and exogenous peer characteristics like gender or ethnic background don't vary over time.

square. Located within the network, there are three partially overlapping peer groups in form of two gray ovals and one light green oval. Each small green circle stands for one individual, and individuals A, B, and C are highlighted. The arrow between individuals A and B indicates, that there is a reciprocated link between the two of them. This means, A is influencing B, and at the same time B is influencing A. A similar relationship is indicated between individuals B and C. Further arrows indicating links between individuals (green circles) within each peer group (bigger ovals) are omitted for clarity of presentation. Suppose the aim is to estimate peer effects on individual B. All small circles located within the light green oval represent B's peers. Figure 1b highlights peers that A and B have in common by white circles, and peers that B and C have in common by black circles. Consider individual A, as the arrow between A and B indicates, the influence goes in both directions. Thus, in order to estimate the influence of A on B, instruments for A are required. Individuals that are peers of A but not of B, as depicted by the white circles in Figure 1c will serve this purpose. Characteristics and outcomes of all white circles individuals in Figure 1c can be used to instrument the outcome of individual A, when estimating its effect on individual B. Analogously, characteristics and outcomes of all black circle individuals in Figure 1c can be used as instruments for the outcome of individual C, when estimating its effect on individual B. Both, white and black circle individuals in Figure 1c are indirect or second-order peers of individual B. For clarity of presentation Figure 1 shows only second-order peers, however, the partially overlapping peer group strategy can be employed with higher-order peers in the same way. Exploiting intransitivities, i.e. indirect links between individuals within a network relies on the correct representation of connections within networks. Incomplete information on a link between individuals A and C in Figure 1 could bias results. This potential issue will be discussed in length in the robustness section.

The second issue arises due to potential unobservables affecting both, parental investment as well as human capital leading to a correlation between errors term and skills. In order to overcome this as well as possible reversed causality between investment and skills, $\Delta J\boldsymbol{\theta_{i,t}}$ should be instrumented. The usual approach in this is to use a lag that is far enough in the past so break the correlation, which means in the current context, that e.g. $\Delta J\theta^C_{i,2} = J\theta^C_{i,2} - J\theta^C_{i,1}$ is instrumented $J\theta^C_{i,0}$.

In order to strengthen the instrumental strategy and capture the joint evolution, equation (5) is extended to a simultaneous equation system accounting for changes in i's skills directly. This allows to account for direct peer effects on i's skills ($\boldsymbol{\delta_4}$) and captures the

Figure 1: Overlapping Peer Groups - Example



(a) Whole network (b) Overlapping peers (c) Non-overlapping peers

Figure 1a depicts a network in form of a big gray square, with three partially overlapping peer groups marked by two gray and one light green oval. Each peer group includes several individuals depicted by small green circles. Three individuals (A, B, C) are highlighted. Figure 1b emphasizes in white common peers of individual A and C, and in black common peers of individual B and C. Figure 1c highlights non-overlapping peers of individual A in white, and non-overlapping peers of individual B in black.

reversed effect of parental investment on i's skills (δ_3), which would otherwise confound the $\boldsymbol{\alpha}$ in (5).

$$\Delta JI_{it} = \beta_1 + \Delta J\theta'_{i,t}\boldsymbol{\beta_2} + \Delta JG\theta'_{it}\boldsymbol{\alpha} + \Delta JX'_{it}\boldsymbol{\gamma} + \Delta J\epsilon_{it} \qquad \text{(5 revisited)}$$

$$\Delta J\theta^C_{it} = \delta^C_1 + \Delta J\boldsymbol{\theta}'_{i,t-1}\boldsymbol{\delta}^C_2 + \Delta JI_{i,t-1}\delta^C_3 + \Delta JG\boldsymbol{\theta}'_{i,t-1}\boldsymbol{\delta}^C_4 + \Delta JX^C_{i,t-1}\delta^C_5 + \Delta\eta^C_{i,t} \qquad \text{(6a)}$$

$$\Delta J\theta^N_{it} = \delta^N_1 + \Delta J\boldsymbol{\theta}'_{i,t-1}\boldsymbol{\delta}^N_2 + \Delta JI_{i,t-1}\delta^N_3 + \Delta JG\boldsymbol{\theta}'_{i,t-1}\boldsymbol{\delta}^N_4 + \Delta JX^N_{i,t-1}\delta^N_5 + \Delta\eta^N_{it} \qquad \text{(6b)}$$

In the final system, $\boldsymbol{\alpha}$ will show whether parents are responsive to any changes in peers in general (i.e. whether $\boldsymbol{\alpha}$ is significant). Further, the sign will give an indication of whether parents try to compensate for depreciated peer skills thus perceiving them as substitutes to their own investment (i.e. $\boldsymbol{\alpha} < 0$), or whether they consider peers as potential complements or multipliers (i.e. $\boldsymbol{\alpha} > 0$).

The system is structurally identified by using behavioral problems at school as an excluded instrument for cognitive skills, and emotional attachment to the school as an excluded instrument for non-cognitive skills. The investment equation controls for household characteristics that are excluded from the two skill development functions leading to an overall identification of the system. I estimate the system via three-stage least squares

(3SLS) using iterated generalized method of moments (GMM).

In the final estimation, both skill equations (6a) and (6b) have a set of 5 endogenous variables (two skill dimensions of own skills, two peer skill dimensions, and parental investment), and the investment equation has a set of 4 endogenous variables (two child skills, and two peer skills). For the latter, lagged skills for each dimension, and 2nd and 3rd order lagged peer skills compose the set of instruments. For the skill equations, in addition, lagged investment outcomes are included in the set of instruments.

5 Data and Measures

The analysis is based on the Add Health database, which has been designed to study the impacts of the social environment on adolescents' behavior in the United States. The survey was conducted in the academic year of 1994-1995 and collected information on a nationally representative sample of 7th-12th graders in US public and private schools. Around 90,000 students from 132 schools were surveyed in a first In-School sample. Later a sub-sample of around 20,000 students was followed up in In-Home surveys during the years 1996, 2001/02, and 2007/08 (Wave I - Wave IV).[10] Besides information on the respondent's demographics, family background, and daily activities, Add Health contains rich information on individual social networks. Here I focus on students that were first surveyed in school and subsequently followed up for two waves at home.

5.1 Measures

While some data sources provide time-use diaries that specify exact amounts of time spend with the child, Add Health lacks this kind of detailed information. Add Health provides among other things information on performance, behavior, and family relationships which can be considered as proxies for cognitive and non-cognitive skills as well as parental investment.

5.1.1 Skills

The dataset includes measures that aim to capture different dimensions of skills. In terms of *cognitive skills*, yearly updated school grades in the subjects English, Mathematics,

[10] For details on the research design see **?**.

Science, and History [11] are used. With this set of measures principal component analysis is employed to predict one factor that can be interpreted as a cognitive skill. This way higher cognitive skills can be understood as better academic performance.

While cognitive skills are easily related to IQ, *non-cognitive* or *socio-emotional skills* don't have a single definition. Complete inventories of commonly used personality measures like the Big Five are not available for the first waves. However, there are six questions that fit into the Neuroticism of the Big Five. These questions are answered on a five-point likert scale and are described in detail in Table A1a.[12] Three of these questions also relate directly to the Rosenberg self-esteem scale, which measures global self-worth accounting for both positive and negative feelings about the self. In line with the cognitive skill, I use principal component analysis to extract one common factor out of these six measures, which I call self-esteem. Throughout the paper higher non-cognitive skill thus relates to higher self-esteem and self-worth.

For both types of skills also simple measures such as the GPA of all courses taken, or the GPA of only Math and English can be considered, the main results are robust in this regard.

5.1.2 Parental Investment

In the following, two different types of non-pecuniary parental investments will be described. First consider *time investment*. The data includes activities pursued by mothers or fathers together with the child. These activities can be split into "verbal interactions" and "activity interactions".[13] For the first, I consider talk about dating someone, talk about schoolwork or grades, talk about things done at school, talk about personal problems, and have a serious argument on the child's behavior. In terms of activities, I consider all social events (movie, play, museum, concert, sport event), play a sport, go shopping, and church-related activities. These time investment measures are asked as binary questions and refer to the past 4 weeks as of the interview date. For each set of measures principal component analysis is employed. However, I also use measures constructed by standardized averages that yield similar results. Higher time investment thus indicates that parent and

[11] Provided that the student took this course. English and Mathematics are taken by most students, but Science and History are less frequently chosen.

[12] Young and Beaujean (2011) show how questions within the first wave relate to the Big Five Inventory, and that few items available are internally consistent.

[13] A detailed list on the questions used to create parental investment measures see Table A1b.

child are pursuing more verbal or activity interactions together. The implicit assumption here is that pursuing more of these interaction types is a proxy for more actual time spend together.

Second, consider *monitoring* which refers to the number of decisions the child is allowed to make without a parent. These decisions include among others, with whom the child is allowed to spend time, at what time to be home, or what and how much TV to watch. For this parenting style measure, I take the average number of decision the child is not allowed to make. This means increasing monitoring is in line with the parent making more decisions in the name of the child.

5.1.3 Peer Influence

Exploiting the panel structure of the data allows the inclusion of peers in two different ways. On the one hand, friendship groups can be assumed to stay constant so that the change in peers refers to peer skill changes. On the other hand, exploiting the rich information, an updating in friendship networks could be allowed. This would mean along with the peers' skill development, exogenous network characteristics would also vary over time. The second approach is less stringent in its assumptions on how friendships evolve over time, it requires however that there is sufficient variation in individual networks between two academic years.

In the main part of the analysis, I assume peer groups are constant and effects can only be driven by cognitive and non-cognitive skills of peers. Hereby skills are defined as described above, i.e. cognitive skills are based on scholastic performance, and non-cognitive skills refer to self-esteem. The peer measure then captures the average skill level of an individual's friends. In the second part of the paper in addition to average peer skills, average peer characteristics are included.

5.1.4 Other Variables

To assess *health* an index out of ten different health measures is constructed. The index is increasing in better health and is generated using principal component analysis based on questions like *"In the last month, how often did you wake up feeling tired?"* or *"In the last month, how often did you have chest pain?"*. For a full list of items can be found in table A2.

Add Health updates information on household composition in each survey. This allows

accounting for changes in the *household size*. This captures that mothers might give birth again, older siblings could move out or back home, and new living arrangements could lead to new household members.

There is no information on whether or how much time students spend on studying, but various questions target free-time activities. Combining four categories, one variable that increases in the amount of time spend on *free time* activities is created. First there are hobbies like playing a musical instrument, reading, or doing arts and crafts; second, active sports like baseball, softball, or swimming; third, exercise like jogging, karate, gymnastics or dancing; and fourth, spending time with friends.

To control for the *family atmosphere* affecting interactions between parents and children, a variable that subjectively measures how much fun the family has together is included.[14]

5.2 Descriptive Statistics

Due to the differencing strategy and lagged instruments, the present analysis requires information on skills from at least three periods and non-missing values for all control variables restricting the sample to 9,492 observations. Further, friendship nominations, and in particular nominations that can be linked to survey data are required, which reduces the sample to 7,044 students. In the final analysis, students that are in school grade 12 during the first In-Home interview, i.e. Wave I, are excluded. Since those students are in their last school year, including them would result in including only students that repeat the 12th grade, which are likely to be different from students of similar age. Also, in order to make sure that the partially overlapping peer groups exist, very small networks of sizes 2 and 3 are excluded. This leaves a final sample of 3,424 high school students, which is summarized in Table 1.

The sample is balanced in terms of gender and consists mainly of students in their junior years of high school which corresponds to grades 9 and 10. While the majority of students are white, the biggest minority is composed of black students with 17 % of the sample. The majority of mothers and fathers in the sample have at least a high-school degree, while 31% of mothers and 34% of fathers are also college-educated. Only 13 % of mothers are reported to not have an occupation, while around a third is a professional

[14] Alternatively, a question measuring a negative shock like a death in the family could be used. In the analysis, it makes no big difference which of these two measures are employed.

Table 1: Descriptives: Child and Parent Characteristics

	Mean	Std.Dev.	Min.& Max.	N
Female	0.5470	0.4979	0 1	3424
Age	15.1209	1.3965	12 19	3424
Stage in High-School				
Freshmen	0.3034	0.4598	0 1	3424
Junior	0.4889	0.4999	0 1	3424
Senior	0.2077	0.4057	0 1	3424
Race				
White	0.6186	0.4858	0 1	3424
Black	0.1700	0.3757	0 1	3424
Asian	0.0464	0.2105	0 1	3424
Latin	0.1159	0.3202	0 1	3424
Education of Mother				
no degree	0.1159	0.3202	0 1	3424
only HS degree	0.5467	0.4979	0 1	3424
college degree	0.3090	0.4621	0 1	3424
Education of Father				
no degree	0.1082	0.3107	0 1	2596
only HS degree	0.5069	0.5000	0 1	2596
college degree	0.3386	0.4733	0 1	2596
Occupation of Mother				
professional	0.3140	0.4642	0 1	3424
technical, office, sales	0.2418	0.4282	0 1	3424
other job	0.3122	0.4635	0 1	3424
no job	0.1294	0.3357	0 1	3424
Occupation of Father				
professional	0.3151	0.4646	0 1	2596
technical, office, sales	0.0728	0.2599	0 1	2596
other job	0.5705	0.4951	0 1	2596
no job	0.0389	0.1934	0 1	2596
Household Characteristics				
Single Child	0.1732	0.3785	0 1	3424
Number of Siblings	1.9376	1.2286	1 11	3155
First-born Child	0.4822	0.4998	0 1	3397
Enough money to pay bills	0.8482	0.3589	0 1	3352

which includes among other doctors, lawyers, or teachers. In contrast to that, only 4% of the fathers are reported to not have an occupation, while the majority with around 57% has an occupation that does not fall into the category of a professional or technical

worker. Since Add Health is a self-reported survey, information on earnings and wealth includes many missing entries. However, on the question of whether the family has enough money to pay their bills, only 15% responded to have financial problems. Around half of the students in the sample are the firstborn child in their family and 17% have no siblings. For those who are not a single child, the number of siblings ranges between one and eleven with an average number of 2 siblings.

5.3 Friendship Networks

During In-School data collection in 1994/95, each student was asked to nominate up to five male and five female friends from a school roaster listing all students enrolled in a given school. In the follow up In-Home survey, students were asked to nominate again one male and one female friend. Even though students had the possibility to nominate anyone within their school, not all nominated friends are followed up. So it is very well possible that a student nominates a total of 8 friends but only half of them can be considered in the analysis. I restrict the analysis to students that are in peer groups of at least four people in order to avoid results driven by very small group sizes and to guarantee that enough networks satisfy the exclusion restrictions for third-order peers.[15]

Table 2: Outgoing and Incoming Nominations - Networks with minimum size four

	Main[a]				Unrestricted[b]			
	Mean	Std.Dev.	Min	Max	Mean	Std.Dev.	Min.	Max
Nominations out	2.036	1.755	0	9	2.103	1.884	0	9
Nominations in	2.036	1.993	0	16	2.103	2.102	0	17
Reciprocated Links	0.870	1.127	0	7	0.866	1.156	0	8
Networksize	17.416	40.279	4	407	19.203	53.371	4	720

[a] Main refers to the peer-groups in the sample that is used throughout the analysis in the paper.
[b] Unrestricted refers to peer-groups including all individuals that can be followed in the used data waves, including individuals with missings in variables of interest.

Table 2 compares nomination patterns of my main sample, with the unrestricted sample which refers to all individuals that can be followed in two In-Home interviews irrespective of their response pattern. Excluding individuals with missings in variables of interest leads to a decrease in the average network size from 19 to 17, however not in the average number of incoming and outgoing nominations. Hereby incoming nominations count how often an

[15] Out of the 193 non-overlapping networks, 77 have a diameter of at least 4, and 135 have a diameter of at least 3.

individual was listed as a friend by someone, and outgoing nominations are the number of friends an individual listed herself.

Even though every student can nominate up to 10 total friends, in the considered sample students nominate on average 2.02 friends. A concern might be that excluding some friends due to missing data could lead to a completely different peer group. To check whether this is a concern here, I compare average peer characteristics of the peer groups that are used in the analysis, with the average peer group characteristics in the networks based on the unrestricted sample, i.e. before students with missings are excluded. Results in Table 3 indicate that for the students in my main sample, the average peer composition stays stable after excluding friends with missing information. Only age seems a little concerning since after the exclusion, peers are on average 0.35 years younger. However, everything else including gender, race and parental background are comparable for both sets of peers. Also, there is no difference in the average level of the PPVT[16] score indicating that the average peer cognitives are not affected by the exclusion of peers with missing information.

Looking at children inside the same classroom, usually, it can be observed, that gender or similar background and interests increases the likelihood of becoming friends. Documenting and accounting for endogenous network formation is very important (Carrell et al., 2013). Neglecting to do so can bias findings and result in misleading interventions. In the present study, homophily in exogenous characteristics like gender or race would not be a problem since a differencing approach under the assumption of time-constant friendships is used. However, skills are allowed to evolve, which is not necessarily taken care of by differencing. Homophily in skills, for instance, would mean, that the source of a positive relationship between peer and own skills can be due to social influence of interest as well as sorting of students along with skills. Using network fixed effect partially controls for this, wherein an assessment of how good this works in my context is provided in the robustness section.

[16]This is a computerized and abridged version of the Peabody Picture Vocabulary Test-Revised. The test works as follows, the interviewer reads out loud a word and the respondent has to select the illustration that fits best to the meaning.

Table 3: Characteristics of Nominated Friends

	Peer-groups		
	Main	Unrestricted	Difference
Female	0.4637	0.4709	-0.0072
	[0.4069]	[0.394]	[0.4599]
Male	0.3715	0.3848	-0.0133
	[0.3878]	[0.3779]	[0.151]
Race			
white	0.5362	0.5417	-0.0056
	[0.4788]	[0.4738]	[0.6288]
black	0.131	0.1373	-0.0063
	[0.3197]	[0.3241]	[0.4216]
asian	0.0357	0.039	-0.0033
	[0.1741]	[0.1794]	[0.4411]
other	0.0401	0.0407	-0.0000
	[0.1626]	[0.155]	[0.8769]
Age	12.6789	13.0071	-0.3282**
	[5.7651]	[5.4833]	[0.0158]
PPVT Score	44.6539	45.2603	-0.6063
	[29.4611]	[28.3531]	[0.3856]
College Degree			
Mother	0.2514	0.2541	-0.0027
	[0.3628]	[0.3533]	[0.7519]
Father	0.212	0.211	0.001
	[0.3369]	[0.3239]	[0.8995]
N Individuals	3,424	3,424	3,424

Notes: Main refers to peer-groups in the sample that is used throughout the paper. Unrestricted refers to peer-groups including all individuals that can be followed in the used data waves, irrespective of missings.

6 Results

6.1 Main Results

The focus here is on how far parents adjust their investment patterns in case their child's skills change. Hereby observing a negative coefficient indicates that parents pursue a compensating strategy. For example, suppose there is a decrease in cognitive skill of the child which can be observed by a decrease in school performance, where we observe parents increase their investment to compensate for the "skill loss". In case a positive sign of the coefficient is observed, parents would rely on a reinforcing strategy. This means that if there is an increase in the child's skill, then parents increase their investment to further

boost its development.

The main results are presented in Table 4, wherein the first two columns refer to maternal investment, columns three and four refer to paternal investment, and column five focuses on monitoring which does not distinguish between mothers and fathers. Each column presents results from a separate estimation of a system with two skill equations, referred to as *Supplementary Equations*, and an investment equation which is the main equation of interest and reported under *Main Equation*. Results on controls are omitted from the table for clarity but can be found in Table A3 in the appendix.

Comparing columns the top panel of Table 4 it can be seen that both, mothers and fathers respond to changes in their own child's as well as their peers' skills. However, there is no uniform response in the sense that depending on the skill dimension and the particular parent, the underlying strategy seems to differ. Column one shows, that mothers do not respond to cognitive or non-cognitive skill changes of their child in terms of verbal investment. However, whenever their child's health decreases by one standard deviation, mothers on average increase their verbal investment by 0.055 standard deviations. An even stronger verbal compensation occurs, whenever their child's peers experience a decrease in their cognitive skills. In contrast to this, mothers adjust their activity investment solely in response to their own child's non-cognitive skills. In particular, a one standard deviation increase in the child self-esteem leads on average to a 0.233 standard deviation increase in the joint activities of mother and child.

While mothers distinguish between in their means of a reaction between their own child and its peers, for fathers a different pattern emerges. In contrast mothers, fathers are unresponsive to health changes of their children. Fathers react to changes in cognitive skills of their own child and change in non-cognitive skills of their child's peers. With a one standard deviation increase in cognitive skills of their own child fathers increase on average their joint activities by 0.173 standard deviations. Similarly, a higher level of average peer self-esteem is reinforced with more frequent activities of fathers and children.

Overall, both parents reward their children for improved skills using joint activities, but while mothers reinforce non-cognitive skills gains, fathers do so for cognitive skills. In terms of peers, parents react to the opposite skill as they do for their own child. Mothers are responsive to cognitive skills changes of friends, while fathers respond to changes in peers' self-esteem.

The last column considers monitoring as a form of investment, wherein a higher level of monitoring is in line with the parent making more decisions in the name of the child.

Table 4: Parental Investment and Child Skills

	Parental Investment				
	Mother		Father		
	Verbal [1]	Activity [2]	Verbal [3]	Activity [4]	Monitoring [5]
			Main Equation		
Dep.Var.: Parental Investment					
Cognitive Skill	0.026	0.011	0.118	0.173*	-0.035
	[0.124]	[0.126]	[0.102]	[0.104]	[0.136]
Self-Esteem	0.042	0.233**	0.054	0.065	-0.087
	[0.117]	[0.118]	[0.050]	[0.049]	[0.128]
Health	-0.055**	-0.013	-0.027	-0.016	0.031
	[0.024]	[0.022]	[0.017]	[0.017]	[0.026]
Peer Cognitive Skill	-0.138**	-0.025	0.002	0.055	-0.146*
	[0.069]	[0.067]	[0.069]	[0.076]	[0.079]
Peer Self-Esteem	0.009	-0.002	0.051	0.133*	0.000
	[0.097]	[0.102]	[0.077]	[0.080]	[0.106]
			Supplementary Equations		
Dep.Var.: Cognitive Skill					
Lag-Cognitive Skill	0.332***	0.336***	0.294***	0.289***	0.321***
	[0.042]	[0.042]	[0.048]	[0.048]	[0.042]
Lag-Self-Esteem	0.039	0.041	0.062	0.070*	0.039
	[0.039]	[0.039]	[0.042]	[0.042]	[0.039]
Lag-Health	0.040	0.046	0.076*	0.077*	0.047
	[0.037]	[0.037]	[0.045]	[0.045]	[0.037]
Lag-Investment	0.039**	0.039**	0.042*	0.042*	0.035*
	[0.019]	[0.019]	[0.022]	[0.023]	[0.019]
Lag-Peer Cognitive Skill	0.113*	0.107	0.136*	0.131*	0.119*
	[0.066]	[0.066]	[0.073]	[0.073]	[0.067]
Lag-Peer Self-Esteem	0.028	0.029	0.020	0.020	0.023
	[0.061]	[0.062]	[0.069]	[0.069]	[0.060]
Dep.Var.: Non-Cognitive Skill					
Lag-Cognitive Skill	-0.025	-0.026	-0.037	-0.037	-0.030
	[0.038]	[0.038]	[0.046]	[0.046]	[0.038]
Lag-Self-Esteem	0.135***	0.137***	0.088*	0.091**	0.122***
	[0.039]	[0.039]	[0.046]	[0.046]	[0.039]
Lag-Health	-0.010	-0.006	-0.033	-0.032	-0.003
	[0.037]	[0.036]	[0.045]	[0.045]	[0.037]
Lag-Investment	0.020	0.019	0.009	0.009	0.018
	[0.018]	[0.019]	[0.022]	[0.022]	[0.018]
Lag-Peer Cognitive Skill	-0.015	-0.014	0.024	0.020	-0.019
	[0.064]	[0.064]	[0.072]	[0.072]	[0.064]
Lag-Peer Self-Esteem	0.064	0.063	0.064	0.066	0.056
	[0.057]	[0.057]	[0.065]	[0.065]	[0.056]
Observations	3424	3424	2299	2299	3332
Test of Overidentifying Restrictions	9.3560	7.3964	14.1539	15.1552	14.1515
p-value	(0.8980)	(0.9648)	(0.3631)	(0.2978)	(0.5874)

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$; Robust standard errors in brackets. Cognitive skill equation controls for time spend on free time activities, behavioral problems in school, and the peer analogs. Non-cognitive skill equation controls for time spend on free time activities, emotional attachment to school, and the peer analog. Investment equation controls for family atmosphere, household size, living conditions, time spend on free time activities, and peer health. For the full set of results including controls see Table A3.

This measure does not distinguish between a particular parent of the child so that the response could be driven by the mother, the father, or as a joint decision. Parents are not responsive to their own child's skill, but in contrast to that for peer cognitive skills, a weak compensation effect prevails. With peers that perform worse in school, parents increase the extent of control over their child's daily decisions.

At the bottom of Table 4 the Hansen J statistic testing for overidentifying restrictions is reported. This statistic is commonly used to test for the validity of instruments and other misspecifications with a significant value indicating concern about the estimation. Across all investment measures this test of overidentifying restrictions cannot be rejected.

6.2 Heterogeneous Results

To assess the underlying drivers of the main results, Table 5 allows for heterogeneous responses on peer skills. The first panel shows results for maternal verbal investment, the middle panel considers paternal activity investment, and the bottom panel shows results on monitoring. Each panel consists of results from five separate estimations, wherein the supplementary equations and some coefficients from the main equation are omitted for clarity but can be found in the appendix.

Column [1] in part (a) of Table 5 tests for differences in the mothers' reaction to peers of their daughters as compared to peers of their sons. Even though the effect seems to be stronger for sons, mothers do not significantly discriminate by the gender of their child. The sample includes students between the ages of 12 to 19, which makes it likely that the mother does not employ the same parenting practices over this whole age range. This is confirmed in column [2] which tests for age differences in the response pattern. The compensation strategy is entirely driven by children that are 15 years of age or younger, which could be because mothers are more aware of the friends during their child's early adolescence or older children might refuse the investment offered by the mother. However, the latter seems more likely given that around 96% of parents report to have met the best friend of their child. This contact with peers does not differ between children that are of age 15 or younger as compared to older students (see part (b) of Table A4). Column [3] allows the response to differ by the child's birth order and shows that the effect is mainly driven by the response to peers of children that are the firstborn in their family. This indicates that verbal investment is time-consuming so that mothers respond to peers when they have a single child but with additional children at home their time constraint gets

Table 5: Heterogeneous Results

(a) Verbal Investment of Mother

Interaction Variable X	Female	Under Age 15	First-born	Expect College	Met peer parents
	[1]	[2]	[3]	[4]	[5]
Dep. Var.: Investment					
Peer Cognitive Skill	-0.224**	0.005	0.005	0.010	-0.212**
	[0.100]	[0.123]	[0.091]	[0.098]	[0.085]
Peer Cognitive Skill * X	0.195	-0.297*	-0.279*	-0.293**	0.352**
	[0.147]	[0.180]	[0.156]	[0.145]	[0.177]
Peer Self-Esteem	-0.135	0.022	0.004	0.093	0.015
	[0.125]	[0.157]	[0.127]	[0.113]	[0.125]
Peer Self-Esteem * X	0.103	-0.049	-0.159	-0.349*	0.009
	[0.196]	[0.197]	[0.205]	[0.209]	[0.203]
Observations	3424	3424	3397	3399	3424
Supplementary Equations	YES	YES	YES	YES	YES
Test of Overidentifying Restriction	13.0353	13.2819	13.2503	12.1360	10.4969
p-value	(0.8368)	(0.7746)	(0.7193)	(0.8401)	(0.8815)

(b) Activity Investment of Father

Interaction Variable X	Female	Under Age 15	First-born	Expect College	Met peer parents
	[1]	[2]	[3]	[4]	[5]
Dep. Var.: Investment					
Peer Cognitive Skill	0.131	0.160	0.079	0.024	-0.018
	[0.115]	[0.114]	[0.070]	[0.087]	[0.073]
Peer Cognitive Skill * X	-0.075	-0.135	-0.005	0.153	0.284*
	[0.177]	[0.157]	[0.119]	[0.174]	[0.148]
Peer Self-Esteem	0.234*	0.209	0.083	-0.035	0.138
	[0.126]	[0.144]	[0.105]	[0.070]	[0.107]
Peer Self-Esteem * X	-0.215	-0.134	-0.042	0.238*	0.004
	[0.177]	[0.174]	[0.162]	[0.124]	[0.167]
Observations	2299	2299	2279	2287	2299
Supplementary Equations	YES	YES	YES	YES	YES
Test of Overidentifying Restriction	16.7724	15.4224	19.7153	18.8881	15.6142
p-value	(0.2685)	(0.3499)	(0.1831)	(0.2189)	(0.4081)

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Robust standard errors are in brackets. Cognitive and non-cognitive skill equations are omitted for clarity. Investment equation controls for family atmosphere, household size, living conditions, time spend on free time activities, and peer health.

Table 5: Heterogeneous Results continued

(c) Monitoring

Interaction Variable X	Female	Under Age 15	First-born	Expect College	Met peer parents
	[1]	[2]	[3]	[4]	[5]
Dep. Var.: Investment					
Peer Cognitive Skill	-0.267**	-0.205	-0.071	-0.077	-0.246***
	[0.121]	[0.132]	[0.099]	[0.109]	[0.095]
Peer Cognitive Skill * X	0.300*	0.163	-0.111	-0.122	0.395**
	[0.178]	[0.177]	[0.173]	[0.156]	[0.197]
Peer Self-Esteem	-0.177	0.048	0.045	0.034	0.098
	[0.124]	[0.178]	[0.144]	[0.131]	[0.117]
Peer Self-Esteem * X	0.317*	-0.048	0.009	-0.013	-0.178
	[0.176]	[0.229]	[0.230]	[0.225]	[0.232]
Observations	3332	3332	3305	3308	3332
Supplementary Equations	YES	YES	YES	YES	YES
Test of Overidentifying Restriction	25.9433	18.8312	17.4152	18.4282	16.6386
p-value	(0.2541)	(0.3383)	(0.4266)	(0.4278)	(0.4791)

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Robust standard errors are in brackets. Cognitive and non-cognitive skill equations are omitted for clarity. Investment equation controls for family atmosphere, household size, living conditions, time spend on free time activities, and peer health.

more stringent.

If the compensation behavior is strategically driven, then this effect should be stronger in case the mother expects there to be a substantial influence on her child or in case her child is already on risk. Results in column [4] show that the response is driven by mothers who have high educational expectations of their child. The variable *expect college* takes a value of one in case the parent reports to be disappointed if their child does not attend college. So it seems, that only mothers who expect their child to succeed in high-school counteract cognitive skill losses of their children's peers. In addition, mothers that have high educational expectations also compensate for non-cognitive skill losses of their children's peers.

If mothers know the parent of their child's friends, then expectations over these friends and knowledge about their skills might be more accurate. The last column in Table 5 tests the difference in the response of mothers who report to have talked to at least four parents of their child's peers in the past month. As can be seen in Table A4, many parents report to have met the parents of the best friend of their child. On average parents seem to talk to

around 2 peer parents within a month. For mothers who had contact to more parents, the compensation effect is significantly weaker. In fact, the net effect even turns positive, so that mothers reinforce cognitive skill gains by increasing verbal investment. It could mean that those mothers have no uncertainty about the parenting behavior of the peers' parents, so that they do not feel the need to take precautions about possible negative spillovers on their child.

Part (b) of Table 5 test for heterogeneities in fathers' activity investment. Overall results are in line with those of mothers reported in part (a). Column [1] shows that also fathers do not discriminate by their child's gender, though the effect seems stronger for sons. Fathers do not differ their response to their child's friends by the age of their child. A reason for that could be that the investment measure is composed of a range of activities so that by the age of the child the exact activity changes but not the sensitivity with respect to peer non-cognitives. Column [3] shows that fathers, as opposed to mothers, do not seem to have time constraint issue. In the case of joint activities, a higher number of children would not necessarily make the fathers' time constraint more stringent. It is possible to include multiple children in these activities so that response to peer skill changes does not differ by the child's birth order.

In line with the results of mothers, the reinforcement strategy is mainly driven by parents who report being disappointed if their child would not attend college. The last column tests for differences by contact with peer parents. If fathers have more contact with the peers' parents, then knowledge about the actual skill level might be more accurate. While the response to changes in peer self-esteem does not differ by the contact to peer parents, fathers with more contact in addition to reinforcing non-cognitive skills also reinforce cognitive skill gains of their children's friends by increasing joint activities.

Part (c) of Table 5 provides heterogeneous results for monitoring. In contrast to time investment of mothers and fathers, parents react differently to peers of sons and peers of daughters when monitoring is considered. Increased control as a reaction to cognitive skill loss of peers is entirely driven by sons, for daughters the non-cognitive dimension seems more important. In particular, in case a daughters' friends have higher self-esteem, parents increase their monitoring by taking more decisions in the name of their daughter. These response patterns are in line with findings in the literature, in the sense that education literature usually finds an academic performance gap favoring girls (see e.g. **?**), so that parents worrying about their sons' but not daughters cognitive performance is reasonable. The psychology literature shows that boys tend to have higher self-esteem during adoles-

cence, and while girls tend to have problems influencing boys, the opposite does not seem to hold (see **?**). So the increase in monitoring due to higher peer self-esteem could be driven by parents' concern about their daughters having certain type of friends influencing their behavior. This can be confirmed by allowing parents to respond to skills and characteristics (see Section 6.3 for detail), estimated separately for boys and girls. Table A11 shows that more male and minority friends actually drive the results for girls reported in column [1] in part (c) of Table 5.

As can be seen in column [2], even though responses to peer cognitive skill changes seem stronger for children that are 15 years or younger, there is no significant difference in the monitoring adjustment by the age of a child. Similarly, birth order as measured by being the firstborn in the family does not lead to a stronger adjustment of monitoring. Even though parents that have high educational expectations of their children seem to react stronger to cognitive skill losses, there seems to be no significant difference to parents with lower expectations.

In line with heterogeneities in time investment, compensation for cognitive skill losses with increased monitoring is driven by parents that had only contact less than four of their child's peers' parents. Those who talked to at least four parents, indicating that they have a better notion of the peers' skills respond significantly less. In fact, the net effect turns not only positive but also insignificant.

Overall heterogeneous indicate that parents respondent strategically to counteract negative spillovers on their own child. To provide an additional test for this conclusion, I allow parents to respond differently along with their own child's ability. In particular, Table 6 allows parents to respond differently to their child's peers in case their own child has below-median cognitive or non-cognitive skills. For both, verbal investment of mothers and monitoring, it can be seen that the compensation behavior is significantly stronger in case the own child has below-median cognitive skills. As opposed to that, fathers' response to peer non-cognitives does not depend on their own child's skill level.

6.3 Changing Friendship Networks

One case in which the assumption of time constant group effects is violated is if there are actual changes in the peer networks. If the group composition changes, it is also likely that group-level characteristics will differ. In this case, changes in network compositions as measured by exogenous characteristics need to be accounted for as well since the parents'

Table 6: Heterogeneous Results - Child's relative ability

Investment Measure	Mother Verbal		Father Activity		Monitoring	
Interaction Variable X	below median		below median		below median	
	cognitive	selfesteem	cognitive	selfesteem	cognitive	selfesteem
	[1]	[2]	[3]	[4]	[5]	[6]
Dep.Var.: Investment						
Peer Cognitive Skill	0.027	-0.055	0.046	0.092	0.024	-0.044
	[0.098]	[0.103]	[0.068]	[0.077]	[0.113]	[0.115]
Peer Cognitive Skill * X	-0.295**	-0.112	0.056	-0.068	-0.319*	-0.141
	[0.148]	[0.150]	[0.123]	[0.118]	[0.167]	[0.164]
Peer Self-Esteem	-0.131	-0.052	0.081	0.108	0.125	0.000
	[0.097]	[0.103]	[0.079]	[0.076]	[0.110]	[0.110]
Peer Self-Esteem * X	0.141	-0.053	-0.099	-0.149	-0.207	0.059
	[0.150]	[0.148]	[0.113]	[0.116]	[0.172]	[0.170]
Observations	3424	3424	2299	2299	3332	3332
Supplementary Equations	YES	YES	YES	YES	YES	YES
Test of Overidentifying Restriction p-value	15.9523 (0.6605)	12.8141 (0.8025)	20.4552 (0.2004)	19.1014 (0.2634)	18.7602 (0.4723)	21.3331 (0.2629)

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Robust standard errors are in brackets. Cognitive and non-cognitive skill equations are omitted for clarity. Investment equation controls for family atmosphere, household size, living conditions, time spend on free time activities, and peer health.

reaction might not be a response to peer skills but rather the peers themselves. This possibility will be considered in this section, where the equation system consisting of (5), (6a), and (6b) will be extended by exogenous peer-group characteristics in each equation.

While allowing for dynamic peer groups is a less stringent assumption as compared to assuming groups to stay constant, it requires that there is sufficient variation in individual networks between two academic years. Table 7 compares friendship nominations over different waves, wherein old nominations refer to those used in the analysis up until now, and new nominations make use of information form follow-up waves. While the average number of friends a student nominates (outgoing nominations), as well as the average number of friends by which a student gets nominated (incoming nominations), is quite stable over time, only on average 37% of friendships indicated during the in-school survey are renewed during follow-up interviews. This low renewal percentage is partly due to the lower number of nominations the students were allowed to make during the follow-up, but also because students indicated new friendships instead. This suggests that for the majority of students in my sample, the peer group composition changes over time. I exploit these

changes to identify parental responses to peer characteristics along with peer skills.

Table 7: Nomination Dynamics

	Nominations				Fraction	
	Old		New		Renewed	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
Nominations out	2.262	1.927	2.105	2.076	0.370	0.383
Nominations in	2.262	2.174	2.105	2.456	0.361	0.386
Reciprocated Links	1.057	1.219	0.952	1.270		
Network size	54.196	72.836	7.302	34.272		

This approach allows for the inclusion of additional instruments that naturally occur in the dynamic context. In the previous section, peer skills were instrumented by lagged skills of higher-order friends. In this section these instruments will be combined with the changes in the network members. As an example, in addition to friends-of-friends, old-friends-of-new-friends and new-friends-of-old-friends are used to instrument skills and characteristics of immediate friends. In what follows, I first present results on estimations allowing for exogenous peer effects only (in Table 8), and in second step I allow an influence from both peer skills and peer characteristics.

Table 8 reports results from 5 separate estimations of a system with two skill and one investment equations. Results on the two skill equations as well as additional controls in the investment equation are omitted clarity (for the complete results see Table A8). The first two columns use maternal investment, columns [3] and [4] use paternal investment, and the last column uses parental monitoring as the investment measure.

Allowing parents to respond to peer characteristics only, I show that both mores and fathers value the peers' background. with a higher fraction of peers with at least high-school educated mothers, mother increase the verbal investment into their own child. A higher fraction on white friends is perceived as a substitute leading mothers to decrease their verbal investment.

In contrast to the main results, where mothers did not respond to the skills of their child's peers in terms of joint activities, they do take peer group composition into account. With a higher fraction of white students in their child's peer group, mothers increase the joint activities with their child. Further, a higher fraction of female friends leads to a decrease of joint activities the mother offers her child.

Table 8: Parental Investment and Child Skills - Changing friendship networks with exogenous peer effects only

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
Dep. Var.: Investment					
Cognitive Skill	0.015	0.068	0.011	0.169***	-0.030
	[0.071]	[0.070]	[0.067]	[0.063]	[0.099]
Self-Esteem	0.035	0.207*	0.095	0.024	-0.095
	[0.063]	[0.123]	[0.058]	[0.057]	[0.083]
Health	-0.158	-0.195	-0.086	0.053	-0.040
	[0.130]	[0.145]	[0.095]	[0.097]	[0.183]
Peer Characteristics					
Female	0.007	-0.038**	-0.016	-0.040**	-0.049*
	[0.020]	[0.019]	[0.018]	[0.017]	[0.026]
Mother high-school	0.061*	0.036	0.001	-0.003	-0.052
	[0.031]	[0.031]	[0.032]	[0.028]	[0.043]
White	-0.071*	0.068*	0.007	0.023	0.067
	[0.042]	[0.041]	[0.041]	[0.036]	[0.056]
Minority	-0.016	0.031	-0.017	0.006	0.104**
	[0.033]	[0.033]	[0.036]	[0.036]	[0.047]
Father Professional	0.021	-0.005	0.000	0.043***	-0.024
	[0.017]	[0.017]	[0.015]	[0.014]	[0.024]
Observations	1818	1818	1156	1156	1745
Test of Overidentifying Restrictions	27.9191	35.4492	31.4379	29.4473	27.4869
p-value	(0.3625)	(0.1902)	(0.2124)	(0.2457)	(0.2823)

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Robust standard errors are in brackets. Cognitive and non-cognitive skill equation are omitted for clarity, they include as controls all peer characteristics presented in the table. Investment equation controls for family atmosphere, household size, living conditions, time spend on free time activities, and peer health. For the full set of results see Table A8.

In line with the main results, fathers do not use verbal investment as a response to their child's or their child's peers' skills. However, when activity investment is considered, it can be seen that when fathers are allowed to consider the peer group composition along with peer skills, they respond to changes in peers. It seems that having a higher fraction of peers with professional fathers is reinforced with more activities. In addition, a higher fraction of girls in the friend group is considered as a substitute for joint activities with fathers.

Similar to this, also for parental monitoring, peer characteristics are important. A higher fraction of female peers is seen as a substitute to monitoring, while more minority friends lead to a higher level of parental control.

Since background characteristics and skills are correlated, a concern of the main results presented in Table 4 and in Table 8 actually capture the same response.[17] To test whether parents respond to both peer skills and characteristics, in Table 9 I report results from 5 separate estimations of a system with two skill and one investment equations including both sets of peer measures. Results on the two skill equations as well as additional controls in the investment equation are omitted clarity (for the complete results see Table A6). The first two columns use maternal investment, columns three and four use paternal investment, and the last column uses parental monitoring as the investment measure.

In line with results in Table 4 mothers compensate cognitive skill losses of their child's peers by increasing their verbal investment. The response to peer group composition presented in column [1] of Table 8 persists, and even gets stronger. In addition to increasing verbal investment with a higher fraction of white friends and decreasing it with more female friends, a higher fraction of friends fathers being professionals[18] is perceived complementary to verbal investment. This effect did not prevail in when mother were only allowed to respond to peer group characteristics because both, average peer cognitives and average peer self-esteem, is positively correlated with the fraction of educated fathers.

Comparing results on mothers' activity investment, when peer skills are included, the negative response to a higher fraction of female friends becomes insignificant. The reason for this is that average peer cognitive skills is positively correlated with the fraction of female friends, so that leaving skills out the fraction of female friends partially measures peer cognitive skills.

Comparing results in columns [3] and [4] of Table 8 with those in columns [3] and [4] of Table 9, it can be seen that the significant effect with respect to peer self-esteem documented in the main results disappears. Similarly, also for parental monitoring, peer characteristics rather than peer skills are the main drivers. Note that when peer skills are included, higher monitoring with less female friends loses significance, while more friends with high-school educated mothers leads to less monitoring. This change in pattern can be explained by the positive correlations between peer skills and the fraction of peers with educated mothers, as well as the positive correlation between the fraction of female friends with the fraction of educated mothers.

Overall results in Table 9 show that while mothers consider both peer quality dimensions, fathers and parental monitoring is mainly based on peer quality as measured by the

[17] For details on the correlation patterns see Tables A9 and A10.

[18] The definition of being a professional includes occupations such as doctors, lawyers, teachers etc.

Table 9: Parental Investment and Child Skills - Changing friendship networks

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
Dep. Var.: Investment					
Cognitive Skill	0.064	0.077	0.017	0.157**	-0.041
	[0.074]	[0.073]	[0.069]	[0.067]	[0.106]
Self-Esteem	0.030	0.177*	0.075	0.022	-0.093
	[0.063]	[0.104]	[0.057]	[0.058]	[0.080]
Health	-0.070	-0.189	-0.049	0.072	-0.061
	[0.126]	[0.135]	[0.100]	[0.102]	[0.180]
Peer Skills					
Cognitives	-0.113**	-0.007	-0.043	0.020	0.021
	[0.054]	[0.052]	[0.051]	[0.053]	[0.070]
Self-Esteem	-0.013	0.042	0.042	-0.004	0.087
	[0.047]	[0.041]	[0.044]	[0.046]	[0.057]
Peer Characteristics					
Female	0.028	-0.034	-0.004	-0.043**	-0.044
	[0.026]	[0.024]	[0.021]	[0.021]	[0.031]
Mother high-school	0.077**	0.025	0.005	-0.008	-0.081*
	[0.033]	[0.032]	[0.032]	[0.029]	[0.045]
White	-0.085**	0.070*	-0.010	0.022	0.070
	[0.043]	[0.042]	[0.041]	[0.038]	[0.057]
Minority	-0.045	0.034	-0.034	0.013	0.111**
	[0.035]	[0.036]	[0.036]	[0.036]	[0.050]
Father Professional	0.035*	-0.001	0.011	0.043***	-0.019
	[0.018]	[0.018]	[0.006]	[0.016]	[0.025]
Observations	1818	1818	1156	1156	1745
Test of Overidentifying Restrictions	38.1680	34.5425	33.1427	34.9175	32.6385
p-value	(0.1455)	(0.2200)	(0.2720)	(0.2073)	(0.2493)

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Robust standard errors are in brackets. Cognitive and non-cognitive skill equation are omitted for clarity, they include as controls all peer characteristics presented in the table. Investment equation controls for family atmosphere, household size, living conditions, time spend on free time activities, and peer health. For the full set of results see Table A6.

peer group composition.

7 Robustness

7.1 Potential Threats

7.1.1 Endogenous Network Formation

The estimation employed above rests on the assumption that potential peer-group level unobservables are time constant and thus eliminated through the combination of first-differences and group fixed effects. This is in line with keeping peer networks constant within the estimation period. Peer groups are based on the first nomination lists available and assumed to stay the same over throughout the analysis. This assumption was relaxed in section 6.3.

In a single period context network fixed effects are used to control for sorting into networks due to unobservables that are common to all individuals within a group. The data is treated as a quasi-panel to average-out group constant unobservables. With an actual panel available, the key assumption of group-level conditional exogeneity, $E[\epsilon_{it}|\mu_g, G] = 0$, can be changed into $E[\epsilon_{it}|\mu_i, G] = 0$ or extended to $E[\epsilon_{it}|\mu_i, \mu_g, G] = 0$.

The first, $E[\epsilon_{it}|\mu_g, G] = 0$, will lead to inconsistent estimates if there are unobserved shocks that are not common to all individuals within a group. The second, $E[\epsilon_{it}|\mu_i, G] = 0$, assumes that conditional on individual level unobservables, peer groups are formed exogenously. However, if there are unobservables common to individuals in a given group that vary over time, estimation results will be inconsistent. The third combines these two by conditioning exogeneity on both, individual and group level unobservables. Conditioning period wise on group fixed effects and across periods on individual fixed effects takes time-varying group level unobservables into account. However, in case there are time-varying unobservables on individual level affecting both, the friendship link formation and the skill and investment development, results will be inconsistent.

I check the validity of these exogeneity assumptions using a network formation model that is commonly used in the literature on dyadic network formation based on homophily (see e.g. Fafchamps and Gubert, 2007; Graham, 2017). Assuming that homophily, i.e. the tendency of individuals to socialize with those similar to themselves, is an appropriate approximation of the underlying network formation, the likelihood of observing a link can

be described in characteristic distances of two individuals.

$$g_{ij,g} = \beta + \sum_{k=1}^{K} \gamma_{1k} \mathbb{1}\{ x_{ik,g} = x_{jk,g}\} + \sum_{l=1}^{L} \gamma_{2l} \frac{1}{|x_{il,g} - x_{jl,g}|} + \delta|\eta_{i,g} - \eta_{j,g}| + \mu_g + u_{ij,g} \quad (7)$$

Where the distance between the K categorical and binary variables is defined by their equality and distances between the L continuous variables is measured by the inverse of their absolute difference. In addition to observable characteristics, the error terms from the main equations $\eta_{i,g}$ are included as well. The parameter δ is of main interest, it captures time-varying unobservables in the main equation. A significant coefficient would indicate that homophily in time-varying unobservables partly explains initial network formation. This would indicate that the approach intended to control for selection bias in the main equation failed, leading to inconsistent estimates.

I estimate this network formation model separately for a specification including only individual level first differences, and one combining first-differences with group fixed effects. Hereby each equation of the system composed by (5), (6a), and (6b) is tested separately.

Table 10: Endogenous Network formation

	No Group Fixed effects			Main Specification		
	Cognitive	Non-Cognitive	Investment	Cognitive	Non-Cognitive	Investment
	[1a]	[1b]	[1c]	[2a]	[2b]	[2c]
Residuals	0.000012	-0.00142	-0.00016	0.00004	0.00013	-0.00010
	[0.00004]	[0.00109]	[0.00018]	[0.00005]	[0.00011]	[0.00018]
Individual and Peer Controls	YES	YES	YES	YES	YES	YES
Group Fixed Effects	NO	NO	NO	YES	YES	YES
Observations	167025	167025	167025	167025	167025	167025

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Robust standard errors are in brackets. Residuals included in columns [1a]-[1b] are based on a simultaneous system including first differences. Residuals in columns [2a]-[2c] are based on a simultaneous system combining group fixed effects and first differences. Each column in a separate logistic regression.

Table 10 shows results from logistic regressions based on residuals from the main specification and one that uses solely first-differences. Results in columns 1a through 1c show that for both, skill and investment equations, using only first differences is enough to control for unobservables influencing friendship formation. In addition to that, columns 2a-2c provide results from a specification including both, first differences and group fixed effects. For none of the three equations there is a significant correlation in the likelihood of a link and the residuals of each equation.

In my analysis, I follow the more conservative strategy of combining first differences

and group fixed effects. Even though also first differencing seems to solve the potential endogenous network formation, using network fixed effects means comparing students that are exposed to similar schools, teachers, and social events.

7.1.2 Observability of Excluded Peers

The strategy of partially overlapping peer groups relies on the observability and inclusion of all connections of an individual. Thus a threat to exogeneity emerges if the observed networks do not depict the real networks. To give an example, see Figure 2 which is an extension of Figure 1.

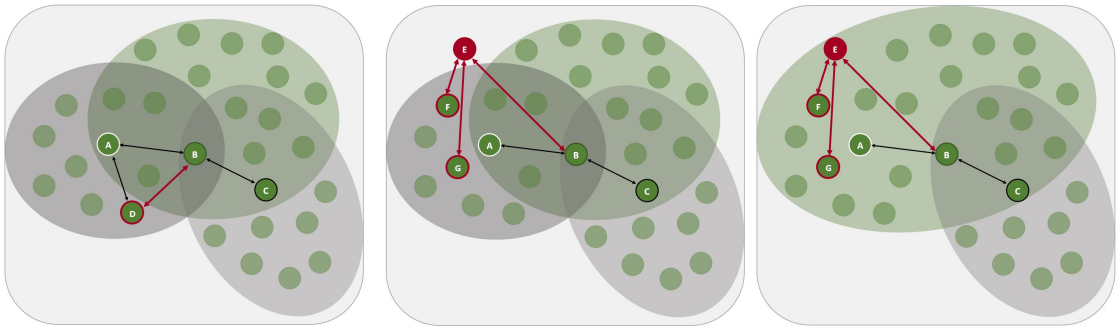
Consider Figure 2a and suppose all highlighted individuals, A, B, C, and D are observed, but only the links depicted by black arrows are observed in the data. Based on that individual D would qualify as an instrument for individual A, however, if in reality there is a direct connection between individual D and B (red arrow) then the exclusion restriction would be violated. In the Add Health survey students are allowed to nominate up to five male and five female friends. If the total number of 10 friends is too restrictive, then non-observability of some friends could be a severe problem.[19]

Figure 2b depicts a case in which an individual (here E) is entirely not observed. Based on observable information individuals F and G qualify as instruments for individual A since they are connected to B only via A. However suppose there exists an individual E, that is connected to individuals B, F, and G. Then the exclusion restriction, that the influence of F (or G) on B only works through A is violated. In particular, while with observed information (left) the network (big gray square) would be partitioned in 3 subgroups (the ovals), in reality, the network would only consist of two subgroups (right).

In the Add Health survey students are allowed to nominate not only students that are part of the study, but also others that attend the same school, or the sister school. This means that there is a chance, that some existing links as depicted in 2b are likely to be not observed. Table 11 compares the total number of nominated friends in column 1 with the number of nominated friends that are part of the Add Health study in column 2. While the number of overall nominated friends (column 1) significantly differs from nominated friends that are part of the survey (column 2), for the majority of students in my sample the overall nominated friends completely coincide with nominated friends that are part of

[19] One possibility could be to use undirected networks, which means if A indicates a link with B the reverse is also assumed to hold. This would increase the restriction of 10 friends, however, at the same time, it would decrease the intransitivity within networks leading to weaker instruments.

Figure 2: Overlapping Peer Groups - Observability



(a) Unobservable Link (b) Unobservable Individual

Figure 2a depicts a network in form of a big gray square, with three partially overlapping peer groups marked by two gray and one light green oval. Each peer group includes several individuals depicted by small green circles. Four individuals (A, B, C, D) are highlighted. The Individuals A, B, C and the links between them (depicted by the black arrows) are observed, individual D surrounded in red is observed, but the link between D and B (red arrow) is not observed by the econometrician. The two Figures 2b depict a case in which an individual E (in red) and the links of individual E (red arrows) are not observed by the econometrician. The left figure captures the partially overlapping peer groups that are constructed based on observed information, the right contrasts the actually situation.

the Add Health study (column 4).

To ensure that higher-order links exist and milden threats to exogeneity by non-observed links, I exclude very small peer groups of the sizes two and three, which could be small subgroups of bigger peer networks with a non-observable friend to link them. In addition, I re-weight the adjacency matrix based on the interaction intensity between two students. Exploiting information on whether and how students report having interacted with their nominated friends in the weeks prior to their interviews, friendships with more interaction are given a higher weight. Doing so allows to focus on the most prevalent friendships of an individual and implicitly assumes that the influence of a link depends on the "strength" of that connection as measured by frequency of interaction.

The present analysis is limited to friendships within the high school a student attends. Each student may have friends living in the same neighborhood but attending a different school. Since the data only allows one to follow friendships within the sampled schools, the results are limited to within-school friends and are likely to be prone to measurement error with respect to the peer group definition.

Table 11: Number of Nominated Friends

	Total	Add Health	difference	all coincide
Total nominations	7.0441	6.5908	0.4533***	0.7757
	(2.9549)	(3.0172)	[0.0000]	(0.4172)
Male nominations	3.4547	3.2012	0.2535***	0.8496
	(1.7757)	(1.815)	[0.0000]	(0.3575)
Female nominations	3.5894	3.3896	0.1998***	0.8674
	(1.7893)	(1.8113)	[0.0000]	(0.3392)
Observations		3,424		

Notes: Column 1 refers to the total number of nominations. Column 2 includes only those nominations that refer to students part of the Add Health study. Column 3 reports the difference in means between the original number of nominated friends and those friends who can be followed up on. The last column reports the fraction of individuals for whom all initial nominations were within the Add Health sample.

7.2 Alternative Specifications

The results presented are robust with respect to alternative definitions of variables. If for parental investments and both skills simpler measures such as averages or weighted averages of measures are used, the results look very similar. Also using clustered standard errors on the peer group level does not have a major impact on the results.

The above-presented results are robust to alternative lower bounds of peer group sizes. If instead of a minimum group size of four a minimum of ten students is chosen, the sample size decreases by around 700. Due to this, the effects get slightly weaker in terms of their significance but still persist.

8 Conclusion

The aim of this paper is to answer three questions describing parenting behavior. First, whether and in how far parents take potential peer effects into account when they invest in their child. Second, who is driving the response to peer quality. And third, what peer quality dimension is the parent reacting on. I show that parents change their behavior in response to changes in the skills or the characteristics of their child's peers. Interestingly, I find that mothers and fathers respond in different ways. The following three main results emerge from my analysis. First, parents compensate for cognitive skill losses of their child's peer by increasing monitoring. Also, I provide evidence that parents not only respond to the cognitive performance of peers but also consider peer non-cognitive skills in their investment

decision. In particular, while mothers compensate for cognitive skill losses of their child's peers by increasing verbal investment, fathers reinforce high non-cognitive skills of peers by increasing time spend on joint activities with their child. These response patterns indicate that verbal investment and monitoring are perceived as substitutes to peer cognitive skills, and joint activities are seen as complements to the self-esteem of peers.

Second, allowing parents to react differently in the case of daughters as opposed to sons, I document gender differences for monitoring. While cognitive skill losses of sons' peers are compensated by increased monitoring, for daughters increased peer self-esteem is reinforced with higher levels of monitoring. Adjustments in time investment are mainly driven by parents that have no close relationship with peers' parents, and parents that expect their child to attend college. However, results do not differ by parental education. Adjustments in monitoring and the verbal investment of mothers are mainly driven by children who have below-median cognitive skills, suggesting that parents try to prevent negative spillovers on their "at risk child".

Third, by exploiting repeated information on friendship nominations, I show that parents take peer characteristics along with peer skills into account. In addition to compensating cognitive skill losses, mothers compensate for decreases in the fraction of white friends by increasing verbal interactions. On the other hand, a higher fraction of peers with educated parents leads mothers to reinforce this peer quality gain by increasing verbal investment into their child. As opposed to that, fathers' response and parental monitoring is mainly driven by changes in peer group quality as measured by the composition of peer characteristics rather than peers' skills.

My findings suggest that school or classroom level interventions changing the composition of students will lead to feedback effects through parents. These type of interventions change the potential set of peers and thus can influence friendships that are actually formed. As I show, parents consider peer quality as measured by skills and characteristics in their parenting behavior. This means, depending on the skill considered, the net effect of policy interventions might be under- or overestimated if parental responses are not taken into account.

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9 Appendix

10 Details on Measures

Table A1a reports summary statistics of the variables used to create cognitive and non-cognitive skill measures. The top panel reports the four school subject grades on which the cognitive measure is based. The grades are coded to range between 0 (fail) up to 5 (A). The bottom panel lists six questions on which the self-esteem measure is based. Answers range from 1 (strongly disagree) to 5 (strongly agree).

Table A1: Description: Main Variables

(a) Variables measuring skills

	Question	Mean	Std.Dev.	Answers	N.Ind.
	Cognitive Skill Measures				
Grades in School-Subjects					
Math	Math-grade in the most recent grading period.	2.622	1.209	0 4	3424
English	English-grade in the most recent grading period.	2.857	1.044	0 4	3424
Science	Science-grade in the most recent grading period.	2.593	1.310	0 4	3424
History	History-grade in the most recent grading period.	2.617	1.359	0 4	3424
	Joint measure	Mean	Std. Dev.	Min. Max.	
	Cognitive	0.089	0.931	-3 2	
	Peer Cognitive	0.038	0.982	-4 2	
	Non-Cognitive Skill Measures				
Self-Esteem					
Item 1	You have a lot of good qualities.	4.285	0.713	1 5	3424
Item 2	You have a lot to be proud of.	4.309	0.772	1 5	3424
Item 3	You like yourself as you are.	3.998	0.988	1 5	3424
Item 4	You do everything just about right.	3.688	0.947	1 5	3424
Item 5	You feel socially accepted.	4.075	0.819	1 5	3424
Item 6	You feel loved and wanted.	4.253	0.812	1 5	3424
	Joint measure	Mean	Std. Dev.	Min. Max.	
	Self-Esteem	0.018	0.996	-6 1	
	Peer Self-Esteem	0.011	0.988	-6 2	

Table A1b reports summary statistics of the set of questions used to create verbal investment, activity investment, and monitoring measures. The first panel reports statistics on questions used to create a verbal investment measure separately for mothers and fathers. The second panel reports summary statistics on questions used to create an activity investment measure separately for mothers and fathers. The third panel reports the set of questions, on which the monitoring measure is based. These questions are answered by the child so that no distinction between mothers and fathers is made.

Table A2 reports summary statistics on the ten questions on which the health measure is based. Hereby, answers range from 1 (everyday) to 5 (never).

Table A1: Description: Main Variables continued

(b) Variables measuring parental investment

	Question	Mean	Std.Dev.	Answers	N.Ind.
	Verbal Investment				
Mother					
Item 1	Talked about someone you are dating.	0.508	0.500	0 1	3424
Item 2	Talked about your school work or grades.	0.682	0.466	0 1	3424
Item 3	Talked about other things you have done at school.	0.593	0.491	0 1	3424
Item 4	Talked about personal problems you are having.	0.408	0.492	0 1	3424
Item 5	Had a serious argument on your behavior.	0.335	0.472	0 1	3424
Father					
Item 1	Talked about someone you are dating.	0.290	0.454	0 1	2750
Item 2	Talked about your school work or grades.	0.564	0.496	0 1	2750
Item 3	Talked about other things you have done at school.	0.493	0.500	0 1	2750
Item 4	Talked about personal problems you are having.	0.182	0.386	0 1	2750
Item 5	Had a serious argument on your behavior.	0.252	0.434	0 1	2750
	Joint measures	Mean	Std. Dev.	Min. Max.	
	Maternal Investment	0.156	0.630	-1 1	
	Paternal Investment	0.528	0.358	-0 1	
	Activity Investment				
Mother					
Item 6	Worked on a project for school together.	0.142	0.349	0 1	3424
Item 7	Went together to a movie, play, museum, concert, or sports event.	0.268	0.443	0 1	3424
Item 8	Played sports together.	0.096	0.295	0 1	3424
Item 9	Went shopping togther.	0.730	0.444	0 1	3424
Item 10	Attended a church related event together.	0.428	0.495	0 1	3424
Item 11	Have done nothing of the above mentioned.	0.016	0.125	0 1	3424
Father					
Item 6	Worked on a project for school together.	0.118	0.322	0 1	2750
Item 7	Went together to a movie, play, museum, concert, or sports event.	0.249	0.432	0 1	2750
Item 8	Played sports together.	0.316	0.465	0 1	2750
Item 9	Went shopping togther.	0.237	0.425	0 1	2750
Item 10	Attended a church related event together.	0.340	0.474	0 1	2750
Item 11	Have done nothing of the above mentioned.	0.082	0.274	0 1	2750
	Joint measures	Mean	Std. Dev.	Min. Max.	
	Maternal Investment	0.182	0.551	-1 2	
	Paternal Investment	0.542	0.343	0 2	
	Parental Monitoring				
Item 1	Not own decision when to be home on weekend nights	0.683	0.465	0 1	3424
Item 2	Not own decision with whom to hang out	0.125	0.331	0 1	3424
Item 3	Not own decision when to go to bed on week nights	0.328	0.470	0 1	3424
Item 4	Not own decision what to eat	0.165	0.372	0 1	3424
Item 5	Not own decision what to wear	0.086	0.280	0 1	3424
Item 6	Not own decision how much TV to watch	0.156	0.363	0 1	3424
Item 7	Not own decision what to watch on TV	0.213	0.410	0 1	3424
	Joint measure	Mean	Std. Dev.	Min. Max.	
	Monitoring	0.082	0.871	-1 4	

Table A2: Description: Variables Measuring Health

Health					
	In the last month, how often...				
Item 1	...did you feel really sick?	4.243	0.747	1 5	3424
Item 2	...did you wake up feeling tired?	3.139	1.221	1 5	3424
Item 3	...did you have skin problems, such as itching or pimples?	3.576	1.129	1 5	3424
Item 4	...were you dizzy?	4.400	0.823	1 5	3424
Item 5	...did you have chest pain?	4.604	0.693	1 5	3424
Item 6	...did you have a headache?	3.584	0.870	1 5	3424
Item 7	...did you have aches, pains, or soreness in your muscles or joints?	3.630	0.958	1 5	3424
Item 8	...did you have a stomachache?	3.880	0.747	1 5	3424
Item 9	...did you have trouble eating, or a poor appetite?	4.324	0.876	1 5	3424
Item 10	...did you have trouble falling asleep or staying asleep?	4.014	1.041	1 5	3424
	Joint measures	Mean	Std. Dev.	Min. Max.	
	Health	0.003	0.996	-6 2	
	Peer Health	0.002	1.000	-8 3	

11 Full Set of Results

In Table A3 I report the full set of results, i.e. including all controls, from the main regression analysis. Hereby The *Main Equation* estimated is the investment equation, while the cognitive and non-cognitive equation are reported under *Supplementary Equation*. Each column reports results on separate estimation of the system described by equations 5, 6a, and 6b. In each row, a different investment measure is used, which is indicated in the first row of the table.

Table A3: Parental Investment and Child Skills - full results

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
			Main Equation		
Dep.Var.: Parental Investment					
Cognitive Skill	0.026	0.011	0.118	0.173*	-0.035
	[0.124]	[0.126]	[0.102]	[0.104]	[0.136]
Self-Esteem	0.042	0.233**	0.054	0.065	-0.087
	[0.117]	[0.118]	[0.050]	[0.049]	[0.128]
Health	-0.055**	-0.013	-0.027	-0.016	0.031
	[0.024]	[0.022]	[0.017]	[0.017]	[0.026]
Peer Cognitive Skill	-0.138**	-0.025	0.002	0.055	-0.146*
	[0.069]	[0.067]	[0.069]	[0.076]	[0.079]
Peer Self-Esteem	0.009	-0.002	0.051	0.133*	0.000
	[0.097]	[0.102]	[0.077]	[0.080]	[0.106]
Family Atmosphere	-0.012	-0.004	-0.024	-0.022	-0.040
	[0.022]	[0.022]	[0.016]	[0.016]	[0.025]
Household Size	0.242***	0.187***	0.196***	0.170***	0.187***
	[0.037]	[0.038]	[0.033]	[0.033]	[0.041]
Living Conditions	0.015	0.014	0.024	0.014	0.011
	[0.019]	[0.018]	[0.015]	[0.016]	[0.021]
Free Time Activities	0.026	0.023	-0.003	0.002	0.019
	[0.019]	[0.018]	[0.015]	[0.015]	[0.021]
Peer Health	-0.050	-0.024	-0.014	-0.021	0.001
	[0.032]	[0.031]	[0.028]	[0.029]	[0.039]
			Supplementary Equations		
Dep.Var.: Cognitive Skill					
Lag-Cognitive Skill	0.332***	0.336***	0.294***	0.289***	0.321***
	[0.042]	[0.042]	[0.048]	[0.048]	[0.042]
Lag-Self-Esteem	0.039	0.041	0.062	0.070*	0.039
	[0.039]	[0.039]	[0.042]	[0.042]	[0.039]
Lag-Health	0.040	0.046	0.076*	0.077*	0.047
	[0.037]	[0.037]	[0.045]	[0.045]	[0.037]
Lag-Investment	0.039**	0.039**	0.042*	0.042*	0.035*
	[0.019]	[0.019]	[0.022]	[0.023]	[0.019]
Lag-Peer Cognitive Skill	0.113*	0.107	0.136*	0.131*	0.119*
	[0.066]	[0.066]	[0.073]	[0.073]	[0.067]
Lag-Peer Self-Esteem	0.028	0.029	0.020	0.020	0.023
	[0.061]	[0.062]	[0.069]	[0.069]	[0.060]
Problems in School	-0.072***	-0.074***	-0.045*	-0.049**	-0.069***

Continued on next page

Table A3: Parental Investment and Child Skills - full results - continued

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
	[0.019]	[0.019]	[0.023]	[0.023]	[0.019]
Peer Problems in School	0.020	0.020	-0.014	-0.015	0.018
	[0.021]	[0.021]	[0.024]	[0.024]	[0.021]
Free Time Activities	0.035**	0.033**	0.034*	0.032*	0.037**
	[0.016]	[0.016]	[0.019]	[0.019]	[0.016]
Peer Free Time Activities	0.019	0.018	-0.007	-0.007	0.020
	[0.019]	[0.019]	[0.022]	[0.022]	[0.019]
Dep.Var.: Non-Cognitive Skill					
Lag-Cognitive Skill	-0.025	-0.026	-0.037	-0.037	-0.030
	[0.038]	[0.038]	[0.046]	[0.046]	[0.038]
Lag-Self-Esteem	0.135***	0.137***	0.088*	0.091**	0.122***
	[0.039]	[0.039]	[0.046]	[0.046]	[0.039]
Lag-Health	-0.010	-0.006	-0.033	-0.032	-0.003
	[0.037]	[0.036]	[0.045]	[0.045]	[0.037]
Lag-Investment	0.020	0.019	0.009	0.009	0.018
	[0.018]	[0.019]	[0.022]	[0.022]	[0.018]
Lag-Peer Cognitive Skill	-0.015	-0.014	0.024	0.020	-0.019
	[0.064]	[0.064]	[0.072]	[0.072]	[0.064]
Lag-Peer Self-Esteem	0.064	0.063	0.064	0.066	0.056
	[0.057]	[0.057]	[0.065]	[0.065]	[0.056]
Emotions about School	0.139***	0.139***	0.135***	0.135***	0.146***
	[0.018]	[0.018]	[0.022]	[0.022]	[0.018]
Peer Emotions about School	0.002	0.002	-0.003	0.000	0.004
	[0.019]	[0.019]	[0.023]	[0.023]	[0.019]
Free Time Activities	0.072***	0.070***	0.064***	0.064***	0.069***
	[0.016]	[0.016]	[0.021]	[0.021]	[0.017]
Peer Free Time Activities	0.036**	0.035**	0.035*	0.035*	0.033*
	[0.018]	[0.018]	[0.021]	[0.021]	[0.018]
Observations	3424	3424	2299	2299	3332
Test of Overidentifying Restrictions	9.3560	7.3964	14.1539	15.1552	14.1515
p-value	(0.8980)	(0.9648)	(0.3631)	(0.2978)	(0.5874)

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Robust standard errors are in brackets.

12 Details on Peers' Parents

One concern of the analysis could be, whether parents know the parents. In case parents do not know the peers of their children, it is very unlikely that the response captured in the main results is driven by the actual peers the child is in contact with. Table A4 reports in part (a) overall averages on how many parents in the sample have met their child's best friend, the parent of the best friends, and with how many parents they talked to in the past four weeks. Only 4% have not met the best friend of their child, and up to 87% report to have met the best friend's parents. In part (b) it can be seen that the fraction of parents who met the best friend and/ or the best friends' parents do not differ between parents of children aged up to 15 and those with older children.

The only difference is that parents of relatively older children talked on average with slightly more parents over the past four weeks.

Table A4: Contact to Peers and Peers' Parents

(a) Main Sample

	Mean	Std.Dev.	Min.& Max.	N.Ind.
Met child's best friend	0.9610	0.1937	0 1	3383
Met best friend's parents	0.8658	0.3409	0 1	3383
Number of parents talked to	2.1746	1.4778	0 4	3379

(b) Differences by age of child

	Age 15 or younger	Above Age 15	Difference
Met child's best friend	0.9606	0.9614	0.00
	[0.1946]	[0.1927]	[0.90]
Met best friend's parents	0.8615	0.8707	0.01
	[0.3455]	[0.3356]	[0.43]
Number of parents talked to	2.0892	2.2726	0.18***
	[1.4682]	[1.4831]	[0.00]

13 Full Set of Results on Dynamic Peer Groups

In Table A6 and A8 I report the full set of results, i.e. including all controls, from the regression analysis using dynamic peer groups. Hereby The *Main Equation* estimated is the investment equation, while the cognitive and non-cognitive equation are reported under *Supplementary Equation*. In each column, a different investment measure is used, which is indicated in the first row of the table.

Each column in Table A8 reports results on separate estimation of the system described by equations:

$$\begin{aligned}
\Delta JI_{it} &= \beta_1 + \Delta J\theta'_{i,t}\boldsymbol{\beta_2} + \Delta JX'_{it}\boldsymbol{\gamma} + \Delta JGX'_{it}\boldsymbol{\beta_3} + \Delta J\epsilon_{it} \\
\Delta J\theta^C_{it} &= \delta^C_1 + \Delta J\boldsymbol{\theta}'_{i,t-1}\boldsymbol{\delta}^C_2 + \Delta JI_{i,t-1}\delta^C_3 + \Delta JX^C_{i,t-1}\delta^C_5 + \Delta JGX^C_{i,t-1}\delta^C_6 + \Delta\eta^C_{i,t} \\
\Delta J\theta^N_{it} &= \delta^N_1 + \Delta J\boldsymbol{\theta}'_{i,t-1}\boldsymbol{\delta}^N_2 + \Delta JI_{i,t-1}\delta^N_3 + \Delta JX^N_{i,t-1}\delta^N_5 + \Delta JGX^N_{i,t-1}\delta^N_6 + \Delta\eta^N_{it}
\end{aligned}$$

Each column in Table A6 reports results on separate estimation of the system described by equations:

$$\begin{aligned}
\Delta JI_{it} &= \beta_1 + \Delta J\theta'_{i,t}\boldsymbol{\beta_2} + \Delta JG\theta'_{it}\boldsymbol{\alpha} + \Delta JX'_{it}\boldsymbol{\gamma} + \Delta JGX'_{it}\boldsymbol{\beta_3} + \Delta J\epsilon_{it} \\
\Delta J\theta^C_{it} &= \delta^C_1 + \Delta J\boldsymbol{\theta}'_{i,t-1}\boldsymbol{\delta}^C_2 + \Delta JI_{i,t-1}\delta^C_3 + \Delta JG\boldsymbol{\theta}'_{i,t-1}\boldsymbol{\delta}^C_4 + \Delta JX^C_{i,t-1}\delta^C_5 + \Delta JGX^C_{i,t-1}\delta^C_6 + \Delta\eta^C_{i,t} \\
\Delta J\theta^N_{it} &= \delta^N_1 + \Delta J\boldsymbol{\theta}'_{i,t-1}\boldsymbol{\delta}^N_2 + \Delta JI_{i,t-1}\delta^N_3 + \Delta JG\boldsymbol{\theta}'_{i,t-1}\boldsymbol{\delta}^N_4 + \Delta JX^N_{i,t-1}\delta^N_5 + \Delta JGX^N_{i,t-1}\delta^N_6 + \Delta\eta^N_{it}
\end{aligned}$$

This is the main system of equations described by 5, 6a, and 6b, extended by the changes in average peer characteristics in each equation.

Table A5: Parental Investment and Child Skills - Changing friendship networks with exogenous effects only - full results

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
			Main Equation		
Dep.Var.: Parental Investment					
Cognitive Skill	0.015	0.068	0.011	0.169***	-0.030
	[0.071]	[0.070]	[0.067]	[0.063]	[0.099]
Self-Esteem	0.035	0.207*	0.095	0.024	-0.095
	[0.063]	[0.123]	[0.058]	[0.057]	[0.083]
Health	-0.158	-0.195	-0.086	0.053	-0.040
	[0.130]	[0.145]	[0.095]	[0.097]	[0.183]
Peers: Female	0.007	-0.038**	-0.016	-0.040**	-0.049*
	[0.020]	[0.019]	[0.018]	[0.017]	[0.026]
Peers: Maternal HS degree	0.061*	0.036	0.001	-0.003	-0.052
	[0.031]	[0.031]	[0.032]	[0.028]	[0.043]
Peers: White	-0.071*	0.068*	0.007	0.023	0.067
	[0.042]	[0.041]	[0.041]	[0.036]	[0.056]
Peers: Minority	-0.016	0.031	-0.017	0.006	0.104**
	[0.033]	[0.033]	[0.036]	[0.036]	[0.047]
Peers: Father Professional	0.021	-0.005	0.000	0.043***	-0.024
	[0.017]	[0.017]	[0.015]	[0.014]	[0.024]
Peer Health	0.005	-0.004	0.022	0.002	0.043
	[0.026]	[0.026]	[0.027]	[0.025]	[0.036]
Family Atmosphere	0.024	0.043*	0.020	0.046***	0.040
	[0.019]	[0.022]	[0.018]	[0.017]	[0.026]
Household Size	0.015	-0.020	0.124***	0.096***	-0.034
	[0.027]	[0.025]	[0.032]	[0.032]	[0.046]
Living Conditions	0.001	0.009	0.032*	0.015	-0.026
	[0.017]	[0.016]	[0.017]	[0.018]	[0.023]
Free Time Activities	-0.014	0.016	0.030*	0.044**	0.020
	[0.022]	[0.025]	[0.017]	[0.018]	[0.029]
			Supplementary Equations		
Dep.Var.: Cognitive Skill					
Lag-Cognitive Skill	0.471***	0.470***	0.438***	0.435***	0.426***
	[0.050]	[0.050]	[0.057]	[0.057]	[0.050]
Lag-Self-Esteem	0.098**	0.095**	0.093	0.117**	0.085*
	[0.045]	[0.045]	[0.057]	[0.056]	[0.045]
Lag-Health	0.055	0.069	0.048	0.053	0.089**
	[0.043]	[0.043]	[0.051]	[0.052]	[0.043]
Lag-Investment	0.072***	0.072***	0.077***	0.079***	0.069***
	[0.024]	[0.024]	[0.027]	[0.028]	[0.024]
Lag-Peer Cognitive Skill	0.029	0.035	0.046	0.039	0.022
	[0.056]	[0.057]	[0.061]	[0.061]	[0.056]
Lag-Peer Self-Esteem	0.020	0.021	-0.030	-0.042	0.015
	[0.047]	[0.047]	[0.056]	[0.056]	[0.047]
Peers: Female	-0.005	-0.001	0.013	0.011	-0.005
	[0.027]	[0.027]	[0.031]	[0.031]	[0.028]
Peers: Maternal HS degree	0.064	0.067	0.174***	0.162***	0.072
	[0.044]	[0.044]	[0.055]	[0.057]	[0.046]

Continued on next page

Table A8: Parental Investment and Child Skills - Changing friendship networks with exogenous effects only - full results - continued

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
Peers: White	-0.021	-0.020	-0.172**	-0.164**	-0.037
	[0.059]	[0.058]	[0.070]	[0.071]	[0.061]
Peers: Minority	-0.042	-0.041	-0.221***	-0.220***	-0.069
	[0.049]	[0.049]	[0.056]	[0.057]	[0.049]
Peers: Father Professional	-0.030	-0.035	-0.051*	-0.048*	-0.035
	[0.025]	[0.025]	[0.027]	[0.027]	[0.025]
Problems in School	-0.112***	-0.112***	-0.101***	-0.104***	-0.112***
	[0.026]	[0.026]	[0.031]	[0.031]	[0.027]
Peer Problems in School	-0.005	-0.003	-0.009	-0.010	-0.012
	[0.021]	[0.021]	[0.027]	[0.027]	[0.021]
Free Time Activities	0.044**	0.043*	0.065**	0.063**	0.056**
	[0.022]	[0.022]	[0.026]	[0.026]	[0.023]
Peer Free Time Activities	0.023	0.019	0.027	0.035	0.014
	[0.021]	[0.021]	[0.024]	[0.024]	[0.021]
Dep.Var.: Non-Cognitive Skill					
Lag-Cognitive Skill	0.001	-0.004	-0.055	-0.054	0.002
	[0.046]	[0.045]	[0.056]	[0.057]	[0.046]
Lag-Self-Esteem	0.144***	0.146***	0.175***	0.172***	0.157***
	[0.049]	[0.048]	[0.065]	[0.065]	[0.051]
Lag-Health	-0.009	-0.013	-0.005	-0.018	-0.010
	[0.044]	[0.043]	[0.053]	[0.053]	[0.045]
Lag-Investment	0.001	0.003	-0.013	-0.018	0.007
	[0.023]	[0.023]	[0.029]	[0.030]	[0.024]
Lag-Peer Cognitive Skill	0.018	0.009	-0.013	-0.011	0.008
	[0.051]	[0.051]	[0.056]	[0.056]	[0.052]
Lag-Peer Self-Esteem	0.078*	0.084*	0.070	0.079	0.057
	[0.043]	[0.043]	[0.053]	[0.053]	[0.044]
Peers: Female	0.021	0.025	0.018	0.020	0.027
	[0.026]	[0.026]	[0.031]	[0.031]	[0.027]
Peers: Maternal HS degree	-0.061	-0.055	-0.071	-0.072	-0.041
	[0.043]	[0.042]	[0.055]	[0.055]	[0.044]
Peers: White	0.042	0.029	0.045	0.049	0.031
	[0.057]	[0.056]	[0.069]	[0.069]	[0.059]
Peers: Minority	0.069	0.062	0.026	0.030	0.044
	[0.044]	[0.044]	[0.057]	[0.057]	[0.045]
Peers: Father Professional	-0.013	-0.008	0.050*	0.050*	-0.009
	[0.025]	[0.025]	[0.029]	[0.029]	[0.025]
Emotions about School	0.159***	0.156***	0.173***	0.172***	0.158***
	[0.025]	[0.024]	[0.029]	[0.030]	[0.026]
Peer Emotions about School	-0.022	-0.021	-0.020	-0.023	-0.020
	[0.021]	[0.021]	[0.026]	[0.026]	[0.021]
Free Time Activities	0.077***	0.075***	0.064**	0.063**	0.084***
	[0.022]	[0.022]	[0.027]	[0.027]	[0.023]
Peer Free Time Activities	0.028	0.026	0.012	0.013	0.029
	[0.021]	[0.021]	[0.025]	[0.025]	[0.022]
Observations	1818	1818	1156	1156	1745

Continued on next page

Table A8: Parental Investment and Child Skills - Changing friendship networks with exogenous effects only - full results - continued

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
Test of Overidentifying Restrictions	27.9191	35.4492	31.4379	29.4473	27.4869
p-value	(0.3625)	(0.1902)	(0.2124)	(0.2457)	(0.2823)

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table A6: Parental Investment and Child Skills - Changing friendship networks - full results

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
			Main Equation		
Dep.Var.: Parental Investment					
Cognitive Skill	0.064	0.077	0.017	0.157**	-0.041
	[0.074]	[0.073]	[0.069]	[0.067]	[0.106]
Self-Esteem	0.030	0.177*	0.075	0.022	-0.093
	[0.063]	[0.104]	[0.057]	[0.058]	[0.080]
Health	-0.070	-0.189	-0.049	0.072	-0.061
	[0.126]	[0.135]	[0.100]	[0.102]	[0.180]
Peer Cognitive Skill	-0.113**	-0.007	-0.043	0.020	0.021
	[0.054]	[0.052]	[0.051]	[0.053]	[0.070]
Peer Self-Esteem	-0.013	0.042	0.042	-0.004	0.087
	[0.047]	[0.041]	[0.044]	[0.046]	[0.057]
Peers: Female	0.028	-0.034	-0.004	-0.043**	-0.044
	[0.026]	[0.024]	[0.021]	[0.021]	[0.031]
Peers: Maternal HS degree	0.077**	0.025	0.005	-0.008	-0.081*
	[0.033]	[0.032]	[0.032]	[0.029]	[0.045]
Peers: White	-0.085**	0.070*	-0.010	0.022	0.070
	[0.043]	[0.042]	[0.041]	[0.038]	[0.057]
Peers: Minority	-0.045	0.034	-0.034	0.013	0.111**
	[0.035]	[0.036]	[0.036]	[0.036]	[0.050]
Peers: Father Professional	0.035*	-0.001	0.011	0.043***	-0.019
	[0.018]	[0.018]	[0.006]	[0.016]	[0.025]
Peer Health	0.016	-0.015	0.008	0.001	0.033
	[0.027]	[0.027]	[0.028]	[0.027]	[0.038]
Family Atmosphere	0.015	0.049**	0.018	0.047***	0.043*
	[0.020]	[0.021]	[0.018]	[0.017]	[0.026]
Household Size	0.012	-0.022	0.124***	0.103***	-0.033
	[0.027]	[0.025]	[0.033]	[0.032]	[0.046]
Living Conditions	-0.002	0.010	0.037**	0.018	-0.030
	[0.017]	[0.016]	[0.018]	[0.017]	[0.023]
Free Time Activities	-0.004	0.016	0.029	0.043**	0.013
	[0.021]	[0.023]	[0.018]	[0.018]	[0.029]
			Supplementary Equations		

Continued on next page

Table A6: Parental Investment and Child Skills - Changing friendship networks - full results - continued

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
Dep.Var.: Cognitive Skill					
Lag-Cognitive Skill	0.473***	0.472***	0.440***	0.441***	0.424***
	[0.050]	[0.050]	[0.057]	[0.057]	[0.050]
Lag-Self-Esteem	0.096**	0.097**	0.094*	0.118**	0.089**
	[0.045]	[0.045]	[0.057]	[0.056]	[0.045]
Lag-Health	0.053	0.066	0.050	0.050	0.083*
	[0.043]	[0.043]	[0.051]	[0.052]	[0.043]
Lag-Investment	0.074***	0.071***	0.076***	0.082***	0.071***
	[0.024]	[0.024]	[0.027]	[0.028]	[0.024]
Lag-Peer Cognitive Skill	0.030	0.033	0.052	0.049	0.026
	[0.056]	[0.057]	[0.061]	[0.061]	[0.056]
Lag-Peer Self-Esteem	0.019	0.021	-0.038	-0.040	0.015
	[0.048]	[0.047]	[0.056]	[0.056]	[0.047]
Peers: Female	-0.004	-0.001	0.007	0.008	-0.003
	[0.027]	[0.027]	[0.031]	[0.031]	[0.028]
Peers: Maternal HS degree	0.063	0.068	0.162***	0.167***	0.077*
	[0.044]	[0.044]	[0.056]	[0.056]	[0.046]
Peers: White	-0.020	-0.024	-0.155**	-0.169**	-0.045
	[0.059]	[0.058]	[0.071]	[0.071]	[0.060]
Peers: Minority	-0.045	-0.045	-0.210***	-0.226***	-0.072
	[0.049]	[0.049]	[0.056]	[0.057]	[0.049]
Peers: Father Professional	-0.030	-0.035	-0.053*	-0.048*	-0.036
	[0.025]	[0.025]	[0.027]	[0.027]	[0.025]
Problems in School	-0.113***	-0.112***	-0.104***	-0.103***	-0.111***
	[0.026]	[0.026]	[0.031]	[0.031]	[0.027]
Peer Problems in School	-0.004	-0.004	-0.007	-0.008	-0.010
	[0.021]	[0.021]	[0.027]	[0.027]	[0.021]
Free Time Activities	0.045**	0.043*	0.063**	0.064**	0.055**
	[0.022]	[0.022]	[0.026]	[0.026]	[0.023]
Peer Free Time Activities	0.023	0.019	0.029	0.034	0.015
	[0.021]	[0.021]	[0.024]	[0.025]	[0.021]
Dep.Var.: Non-Cognitive Skill					
Lag-Cognitive Skill	0.006	-0.006	-0.056	-0.055	-0.002
	[0.046]	[0.045]	[0.056]	[0.056]	[0.046]
Lag-Self-Esteem	0.145***	0.142***	0.173***	0.172***	0.154***
	[0.049]	[0.049]	[0.065]	[0.065]	[0.051]
Lag-Health	-0.009	-0.012	-0.007	-0.019	-0.012
	[0.044]	[0.043]	[0.053]	[0.053]	[0.045]
Lag-Investment	0.002	0.001	-0.014	-0.021	0.006
	[0.023]	[0.023]	[0.029]	[0.030]	[0.024]
Lag-Peer Cognitive Skill	0.015	0.017	-0.008	-0.009	0.005
	[0.051]	[0.050]	[0.056]	[0.056]	[0.052]
Lag-Peer Self-Esteem	0.085**	0.083*	0.074	0.082	0.064
	[0.043]	[0.043]	[0.053]	[0.053]	[0.044]
Peers: Female	0.024	0.024	0.015	0.020	0.029
	[0.026]	[0.026]	[0.031]	[0.031]	[0.027]
Peers: Maternal HS degree	-0.058	-0.055	-0.083	-0.076	-0.036

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Table A6: Parental Investment and Child Skills - Changing friendship networks - full results - continued

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
	[0.043]	[0.042]	[0.055]	[0.054]	[0.044]
Peers: White	0.037	0.028	0.054	0.045	0.025
	[0.057]	[0.056]	[0.070]	[0.069]	[0.059]
Peers: Minority	0.065	0.063	0.040	0.030	0.039
	[0.044]	[0.043]	[0.057]	[0.057]	[0.045]
Peers: Father Professional	-0.012	-0.010	0.051*	0.051*	-0.008
	[0.025]	[0.025]	[0.029]	[0.029]	[0.025]
Emotions about School	0.158***	0.157***	0.173***	0.171***	0.156***
	[0.025]	[0.024]	[0.030]	[0.030]	[0.025]
Peer Emotions about School	-0.023	-0.021	-0.022	-0.025	-0.021
	[0.021]	[0.021]	[0.026]	[0.026]	[0.021]
Free Time Activities	0.079***	0.076***	0.063**	0.063**	0.082***
	[0.022]	[0.022]	[0.027]	[0.027]	[0.023]
Peer Free Time Activities	0.027	0.026	0.012	0.015	0.028
	[0.021]	[0.021]	[0.025]	[0.025]	[0.022]
Observations	1818	1818	1156	1156	1745
Test of Overidentifying Restrictions	38.1680	34.5425	33.1427	34.9175	32.6385
p-value	(0.1455)	(0.2200)	(0.2720)	(0.2073)	(0.2493)

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

In Table A11 I report the full set of results, i.e. including all controls, from the regression analysis using dynamic peer groups separately for girls (column [1]) and boys (column [2]). Hereby the equations and estimation is the same as the results presented in Tbale A6 .

Table A7: Parental Investment and Child Skills - Changing friendship networks by gender

	Parental Investment	
	Monitoring	
	Girls	Boys
	[1]	[2]
	Main Equation	
Dep.Var.: Parental Investment		
Cognitive Skill	-0.116	0.181
	[0.119]	[0.166]
Self-Esteem	-0.174*	0.029
	[0.094]	[0.117]
Health	-0.106	-0.212
	[0.157]	[0.252]
Peer Cognitive Skill	0.067	-0.203*
	[0.088]	[0.121]
Peer Self-Esteem	0.038	0.173
	[0.059]	[0.140]
Peers: Female	-0.072*	0.037

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Table A11: Parental Investment and Child Skills - Changing friendship networks by gender - continued

	Parental Investment	
	Monitoring	
	Girls	Boys
	[1]	[2]
	[0.039]	[0.054]
Peers: Maternal HS degree	-0.076	-0.042
	[0.058]	[0.067]
Peers: White	0.117	-0.027
	[0.075]	[0.083]
Peers: Minority	0.125*	0.009
	[0.071]	[0.070]
Peers: Father Professional	-0.002	0.022
	[0.031]	[0.041]
Peer Health	0.045	0.035
	[0.046]	[0.073]
Family Atmosphere	0.069**	0.045
	[0.035]	[0.041]
Household Size	-0.008	-0.029
	[0.059]	[0.062]
Living Conditions	0.042	-0.081**
	[0.027]	[0.040]
Free Time Activities	0.021	-0.001
	[0.034]	[0.044]
	Supplementary Equations	
Dep.Var.: Cognitive Skill		
Lag-Cognitive Skill	0.455***	0.400***
	[0.066]	[0.069]
Lag-Self-Esteem	0.204***	-0.009
	[0.064]	[0.059]
Lag-Health	0.095*	0.078
	[0.058]	[0.063]
Lag-Investment	0.074**	0.084**
	[0.032]	[0.033]
Lag-Peer Cognitive Skill	-0.007	0.026
	[0.076]	[0.068]
Lag-Peer Self-Esteem	-0.023	0.031
	[0.060]	[0.071]
Peers: Female	-0.003	-0.019
	[0.040]	[0.038]
Peers: Maternal HS degree	0.094*	0.037
	[0.052]	[0.074]
Peers: White	-0.023	-0.038
	[0.077]	[0.089]
Peers: Minority	-0.098	-0.002
	[0.066]	[0.070]
Peers: Father Professional	-0.033	-0.007
	[0.032]	[0.037]
Problems in School	-0.158***	-0.107***
	[0.033]	[0.038]
Peer Problems in School	-0.016	-0.006
	[0.030]	[0.028]

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Table A11: Parental Investment and Child Skills - Changing friendship networks by gender - continued

	Parental Investment	
	Monitoring	
	Girls	Boys
	[1]	[2]
Free Time Activities	0.063**	0.035
	[0.029]	[0.032]
Peer Free Time Activities	0.013	0.050
	[0.026]	[0.032]
Dep. Var.: Non-Cognitive Skill		
Lag-Cognitive Skill	0.093	-0.101*
	[0.064]	[0.059]
Lag-Self-Esteem	0.212***	0.066
	[0.068]	[0.069]
Lag-Health	-0.034	-0.036
	[0.064]	[0.057]
Lag-Investment	0.021	-0.009
	[0.032]	[0.032]
Lag-Peer Cognitive Skill	0.069	0.001
	[0.070]	[0.065]
Lag-Peer Self-Esteem	0.051	0.034
	[0.059]	[0.059]
Peers: Female	0.038	-0.026
	[0.038]	[0.036]
Peers: Maternal HS degree	-0.057	-0.025
	[0.053]	[0.069]
Peers: White	0.085	-0.009
	[0.075]	[0.084]
Peers: Minority	0.018	0.090
	[0.058]	[0.063]
Peers: Father Professional	-0.025	0.003
	[0.036]	[0.032]
Emotions about School	0.138***	0.170***
	[0.033]	[0.036]
Peer Emotions about School	-0.066**	0.029
	[0.030]	[0.027]
Free Time Activities	0.108***	0.044
	[0.031]	[0.032]
Peer Free Time Activities	0.058**	-0.005
	[0.029]	[0.030]
Observations	977	841
Test of Overidentifying Restrictions	37.8983	35.7997
p-value	0.1246	0.1478

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table A8: Parental Investment and Child Skills - Changing friendship networks with exogenous effects only - full results

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
			Main Equation		
Dep.Var.: Parental Investment					
Cognitive Skill	0.015	0.068	0.011	0.169***	-0.030
	[0.071]	[0.070]	[0.067]	[0.063]	[0.099]
Self-Esteem	0.035	0.207*	0.095	0.024	-0.095
	[0.063]	[0.123]	[0.058]	[0.057]	[0.083]
Health	-0.158	-0.195	-0.086	0.053	-0.040
	[0.130]	[0.145]	[0.095]	[0.097]	[0.183]
Peers: Female	0.007	-0.038**	-0.016	-0.040**	-0.049*
	[0.020]	[0.019]	[0.018]	[0.017]	[0.026]
Peers: Maternal HS degree	0.061*	0.036	0.001	-0.003	-0.052
	[0.031]	[0.031]	[0.032]	[0.028]	[0.043]
Peers: White	-0.071*	0.068*	0.007	0.023	0.067
	[0.042]	[0.041]	[0.041]	[0.036]	[0.056]
Peers: Minority	-0.016	0.031	-0.017	0.006	0.104**
	[0.033]	[0.033]	[0.036]	[0.036]	[0.047]
Peers: Father Professional	0.021	-0.005	0.000	0.043***	-0.024
	[0.017]	[0.017]	[0.015]	[0.014]	[0.024]
Peer Health	0.005	-0.004	0.022	0.002	0.043
	[0.026]	[0.026]	[0.027]	[0.025]	[0.036]
Family Atmosphere	0.024	0.043*	0.020	0.046***	0.040
	[0.019]	[0.022]	[0.018]	[0.017]	[0.026]
Household Size	0.015	-0.020	0.124***	0.096***	-0.034
	[0.027]	[0.025]	[0.032]	[0.032]	[0.046]
Living Conditions	0.001	0.009	0.032*	0.015	-0.026
	[0.017]	[0.016]	[0.017]	[0.018]	[0.023]
Free Time Activities	-0.014	0.016	0.030*	0.044**	0.020
	[0.022]	[0.025]	[0.017]	[0.018]	[0.029]
			Supplementary Equations		
Dep.Var.: Cognitive Skill					
Lag-Cognitive Skill	0.471***	0.470***	0.438***	0.435***	0.426***
	[0.050]	[0.050]	[0.057]	[0.057]	[0.050]
Lag-Self-Esteem	0.098**	0.095**	0.093	0.117**	0.085*
	[0.045]	[0.045]	[0.057]	[0.056]	[0.045]
Lag-Health	0.055	0.069	0.048	0.053	0.089**
	[0.043]	[0.043]	[0.051]	[0.052]	[0.043]
Lag-Investment	0.072***	0.072***	0.077***	0.079***	0.069***
	[0.024]	[0.024]	[0.027]	[0.028]	[0.024]
Lag-Peer Cognitive Skill	0.029	0.035	0.046	0.039	0.022
	[0.056]	[0.057]	[0.061]	[0.061]	[0.056]
Lag-Peer Self-Esteem	0.020	0.021	-0.030	-0.042	0.015
	[0.047]	[0.047]	[0.056]	[0.056]	[0.047]
Peers: Female	-0.005	-0.001	0.013	0.011	-0.005
	[0.027]	[0.027]	[0.031]	[0.031]	[0.028]
Peers: Maternal HS degree	0.064	0.067	0.174***	0.162***	0.072
	[0.044]	[0.044]	[0.055]	[0.057]	[0.046]

Continued on next page

Table A8: Parental Investment and Child Skills - Changing friendship networks with exogenous effects only - full results - continued

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
Peers: White	-0.021	-0.020	-0.172**	-0.164**	-0.037
	[0.059]	[0.058]	[0.070]	[0.071]	[0.061]
Peers: Minority	-0.042	-0.041	-0.221***	-0.220***	-0.069
	[0.049]	[0.049]	[0.056]	[0.057]	[0.049]
Peers: Father Professional	-0.030	-0.035	-0.051*	-0.048*	-0.035
	[0.025]	[0.025]	[0.027]	[0.027]	[0.025]
Problems in School	-0.112***	-0.112***	-0.101***	-0.104***	-0.112***
	[0.026]	[0.026]	[0.031]	[0.031]	[0.027]
Peer Problems in School	-0.005	-0.003	-0.009	-0.010	-0.012
	[0.021]	[0.021]	[0.027]	[0.027]	[0.021]
Free Time Activities	0.044**	0.043*	0.065**	0.063**	0.056**
	[0.022]	[0.022]	[0.026]	[0.026]	[0.023]
Peer Free Time Activities	0.023	0.019	0.027	0.035	0.014
	[0.021]	[0.021]	[0.024]	[0.024]	[0.021]
Dep.Var.: Non-Cognitive Skill					
Lag-Cognitive Skill	0.001	-0.004	-0.055	-0.054	0.002
	[0.046]	[0.045]	[0.056]	[0.057]	[0.046]
Lag-Self-Esteem	0.144***	0.146***	0.175***	0.172***	0.157***
	[0.049]	[0.048]	[0.065]	[0.065]	[0.051]
Lag-Health	-0.009	-0.013	-0.005	-0.018	-0.010
	[0.044]	[0.043]	[0.053]	[0.053]	[0.045]
Lag-Investment	0.001	0.003	-0.013	-0.018	0.007
	[0.023]	[0.023]	[0.029]	[0.030]	[0.024]
Lag-Peer Cognitive Skill	0.018	0.009	-0.013	-0.011	0.008
	[0.051]	[0.051]	[0.056]	[0.056]	[0.052]
Lag-Peer Self-Esteem	0.078*	0.084*	0.070	0.079	0.057
	[0.043]	[0.043]	[0.053]	[0.053]	[0.044]
Peers: Female	0.021	0.025	0.018	0.020	0.027
	[0.026]	[0.026]	[0.031]	[0.031]	[0.027]
Peers: Maternal HS degree	-0.061	-0.055	-0.071	-0.072	-0.041
	[0.043]	[0.042]	[0.055]	[0.055]	[0.044]
Peers: White	0.042	0.029	0.045	0.049	0.031
	[0.057]	[0.056]	[0.069]	[0.069]	[0.059]
Peers: Minority	0.069	0.062	0.026	0.030	0.044
	[0.044]	[0.044]	[0.057]	[0.057]	[0.045]
Peers: Father Professional	-0.013	-0.008	0.050*	0.050*	-0.009
	[0.025]	[0.025]	[0.029]	[0.029]	[0.025]
Emotions about School	0.159***	0.156***	0.173***	0.172***	0.158***
	[0.025]	[0.024]	[0.029]	[0.030]	[0.026]
Peer Emotions about School	-0.022	-0.021	-0.020	-0.023	-0.020
	[0.021]	[0.021]	[0.026]	[0.026]	[0.021]
Free Time Activities	0.077***	0.075***	0.064**	0.063**	0.084***
	[0.022]	[0.022]	[0.027]	[0.027]	[0.023]
Peer Free Time Activities	0.028	0.026	0.012	0.013	0.029
	[0.021]	[0.021]	[0.025]	[0.025]	[0.022]
Observations	1818	1818	1156	1156	1745

Continued on next page

Table A8: Parental Investment and Child Skills - Changing friendship networks with exogenous effects only - full results - continued

	Parental Investment				
	Mother		Father		
	Verbal	Activity	Verbal	Activity	Monitoring
	[1]	[2]	[3]	[4]	[5]
Test of Overidentifying Restrictions	27.9191	35.4492	31.4379	29.4473	27.4869
p-value	(0.3625)	(0.1902)	(0.2124)	(0.2457)	(0.2823)

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table A9: Correlations of Skills and Background Characteristics

	Cognitive Skill	Δ Cognitive Skill	Self-Esteem	Δ Self-Esteem	Female	Maternal HS degree	White	Minority
Δ Cognitive Skill	0.450***	1.000						
Self-Esteem	0.149***	0.014	1.000					
Δ Self-Esteem	-0.005	0.015	0.459***	1.000				
Female	0.100***	-0.012	-0.122***	0.034**	1.000			
Maternal HS degree	0.142***	-0.009	0.068***	-0.006	-0.019	1.000		
White	0.111***	-0.021	0.001	0.018	-0.019	0.158***	1.000	
Minority	-0.111***	0.021	-0.001	-0.018	0.019	-0.158***	-1.000	1.000
Father Professional	0.160***	-0.014	0.021	-0.015	-0.030*	0.127***	0.107***	-0.107***

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table A10: Correlations of Friends' Skill Changes and Composition Changes

	Δ Peer Cognitive Skill	Δ Peer Self-Esteem	Δ Peers: Female	Δ Peers: Maternal HS degree	Δ Peers: White	Δ Peers: Minority
Δ Peer Self-Esteem	0.154***	1.000				
Δ Peers: Female	0.160***	0.032**	1.000			
Δ Peers: Maternal HS degree	0.143***	0.191***	0.559***	1.000		
Δ Peers: White	0.154***	0.116***	0.483***	0.674***	1.000	
Δ Peers: Minority	-0.033**	0.137***	0.380***	0.460***	-0.125***	1.000
Δ Peers: Father Professional	0.147***	0.075***	0.244***	0.376***	0.349***	0.148***

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table A11: Parental Investment and Child Skills - Changing friendship networks by gender

	Parental Investment	
	Monitoring	
	Girls	Boys
	[1]	[2]
	Main Equation	
Dep.Var.: Parental Investment		
Cognitive Skill	-0.116	0.181
	[0.119]	[0.166]
Self-Esteem	-0.174*	0.029
	[0.094]	[0.117]
Health	-0.106	-0.212
	[0.157]	[0.252]
Peer Cognitive Skill	0.067	-0.203*
	[0.088]	[0.121]
Peer Self-Esteem	0.038	0.173
	[0.059]	[0.140]
Peers: Female	-0.072*	0.037
	[0.039]	[0.054]
Peers: Maternal HS degree	-0.076	-0.042
	[0.058]	[0.067]
Peers: White	0.117	-0.027
	[0.075]	[0.083]
Peers: Minority	0.125*	0.009
	[0.071]	[0.070]
Peers: Father Professional	-0.002	0.022
	[0.031]	[0.041]
Peer Health	0.045	0.035
	[0.046]	[0.073]
Family Atmosphere	0.069**	0.045
	[0.035]	[0.041]
Household Size	-0.008	-0.029
	[0.059]	[0.062]
Living Conditions	0.042	-0.081**
	[0.027]	[0.040]
Free Time Activities	0.021	-0.001
	[0.034]	[0.044]
	Supplementary Equations	
Dep.Var.: Cognitive Skill		
Lag-Cognitive Skill	0.455***	0.400***
	[0.066]	[0.069]
Lag-Self-Esteem	0.204***	-0.009
	[0.064]	[0.059]
Lag-Health	0.095*	0.078
	[0.058]	[0.063]
Lag-Investment	0.074**	0.084**
	[0.032]	[0.033]
Lag-Peer Cognitive Skill	-0.007	0.026
	[0.076]	[0.068]
Lag-Peer Self-Esteem	-0.023	0.031
	[0.060]	[0.071]
Peers: Female	-0.003	-0.019

Continued on next page

Table A11: Parental Investment and Child Skills - Changing friendship networks by gender - continued

	Parental Investment	
	Monitoring	
	Girls	Boys
	[1]	[2]
	[0.040]	[0.038]
Peers: Maternal HS degree	0.094*	0.037
	[0.052]	[0.074]
Peers: White	-0.023	-0.038
	[0.077]	[0.089]
Peers: Minority	-0.098	-0.002
	[0.066]	[0.070]
Peers: Father Professional	-0.033	-0.007
	[0.032]	[0.037]
Problems in School	-0.158***	-0.107***
	[0.033]	[0.038]
Peer Problems in School	-0.016	-0.006
	[0.030]	[0.028]
Free Time Activities	0.063**	0.035
	[0.029]	[0.032]
Peer Free Time Activities	0.013	0.050
	[0.026]	[0.032]
Dep.Var.: Non-Cognitive Skill		
Lag-Cognitive Skill	0.093	-0.101*
	[0.064]	[0.059]
Lag-Self-Esteem	0.212***	0.066
	[0.068]	[0.069]
Lag-Health	-0.034	-0.036
	[0.064]	[0.057]
Lag-Investment	0.021	-0.009
	[0.032]	[0.032]
Lag-Peer Cognitive Skill	0.069	0.001
	[0.070]	[0.065]
Lag-Peer Self-Esteem	0.051	0.034
	[0.059]	[0.059]
Peers: Female	0.038	-0.026
	[0.038]	[0.036]
Peers: Maternal HS degree	-0.057	-0.025
	[0.053]	[0.069]
Peers: White	0.085	-0.009
	[0.075]	[0.084]
Peers: Minority	0.018	0.090
	[0.058]	[0.063]
Peers: Father Professional	-0.025	0.003
	[0.036]	[0.032]
Emotions about School	0.138***	0.170***
	[0.033]	[0.036]
Peer Emotions about School	-0.066**	0.029
	[0.030]	[0.027]
Free Time Activities	0.108***	0.044
	[0.031]	[0.032]
Peer Free Time Activities	0.058**	-0.005

Continued on next page

Table A11: Parental Investment and Child Skills - Changing friendship networks by gender - continued

	Parental Investment	
	Monitoring	
	Girls	Boys
	[1]	[2]
	[0.029]	[0.030]
Observations	977	841
Test of Overidentifying Restrictions	37.8983	35.7997
p-value	0.1246	0.1478

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$